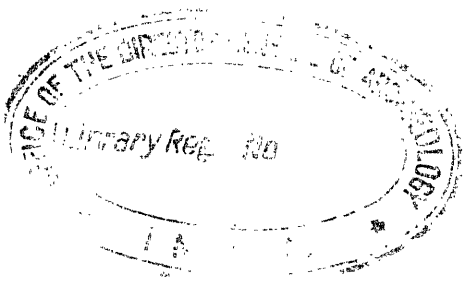
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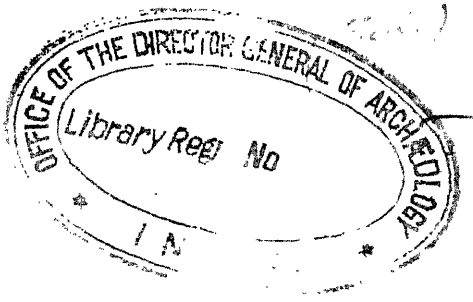
Annual Report of the

Board of Scientific Advice for India

for the year 1911-12



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Annual Report of the

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for the year 1911-12

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3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
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4. The Director, Geological Survey of India.

ANNUAL REPORT FOR 1911-12

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

1911-12

SUMMARY OF PROCEEDINGS.

Twenty-second Meeting held at Simla on the 13th May 1912.

The programmes of work of the various scientific departments were discussed. The Board resolved to accept the programmes as submitted, and to recommend that those departments which so far had not differentiated between more and less important investigations should in future do so and should frame their programmes accordingly. The Board also resolved that in view of the new arrangements regulating the relation of the Imperial Institute to the various scientific departments of Government, future reports on work done and programmes of work to be done at the Imperial Institute on behalf of the Government of India should be sent by the Director of the Imperial Institute direct to the Secretary to the Board of Scientific Advice to the Government of India.

It was also resolved that the individual contributions to the chapters of the Annual Report of the Board concerned with (*a*) Applied Chemistry, (*b*) Economic Botany and (*c*) Economic Entomology should be indicated by separate sub-headings.

Twenty-third Meeting held at Dehra Dun on the 9th November 1912.

The Board considered proposals submitted by their Secretary for securing earlier publication of the Annual Report of the Board. The Board after discussion decided that it was unnecessary to publish in future the programmes of the various scientific departments, but that programmes should be sent to the Secretary to the Board not later than the 15th April for consideration by the Board at the meeting in May and for submission to Government thereafter. It was further resolved that contributions to the Annual Report of the Board should be sent to the Secretary not later than the 1st September, for discussion by the Board at a meeting to be held in October or November.

The draft Annual Report for 1911-12 was then discussed. The Board resolved to accept the report after the omission from it of mere criticisms and expressions of individual opinion as distinct from records of fact. The Secretary was directed to request contributors to the report to append to their respective contributions a list containing the titles of such publications only as have a direct bearing on Indian conditions.

The distribution list of the Annual Report of the Board and new applications for copies were read. The Board resolved to grant the new applications and to authorise the Secretary (*a*) to distribute copies to such officers of the various agricultural departments as might apply for them, (*b*) to increase the number of copies distributed to the public press by ten copies.

The question of whether seismographic observations should be placed under the control of one department was referred by the Board to Sub-Committee A for discussion and report at the next meeting of the Board.

APPLIED CHEMISTRY.

PART I.—ECONOMIC AND INDUSTRIAL CHEMISTRY.

BY

D. HOOPER, F.I.C., F.C.S., F.L.S.,
Economic Botanist, Botanical Survey of India.

This is a review of the chemical work performed during the year apart from that undertaken by the Agricultural and Forest Departments of India. In a few educational institutions the professors and their students have prosecuted a certain amount of research not directly connected with industrial chemistry; it is considered desirable that this work should be recorded, and the titles of the papers in which such work has been published have been included in the bibliography. With the appointment of Professors of Tinctorial Chemistry at Madras and the Sibpur Engineering College, Calcutta, research should be developed in this branch of knowledge. Analyses of economic minerals are carried on by the Geological Survey and private companies, and little has been published during the year on the subject of inorganic chemistry. The present report consequently deals almost exclusively with substances of vegetable origin examined in India and Europe. Since many of these articles are consumed as food and drugs, a knowledge of their actual chemical composition is important in enabling analysts to recognise the genuine products and to detect adulteration. The report records an increased amount of analytical work in connection with economic products and substances having a possible future in the industries and commerce. The material has been arranged according to the following classification:—

1. Natural exudations: rubber, resins and gums.
2. Fixed and volatile oils.
3. Dyes and tans.
4. Fibres and paper.
5. Food substances: flour, sugars, starch.
6. Accessories to human food.
7. Drugs.

I.—Natural Exudations.

The following notes on the examination of indigenous rubbers and resins are taken from the report of the laboratory of the Industrial Section of the Indian Museum.

India-rubber.—Few commercial products have been brought to light by the Abor Expedition, but a sample of rubber obtained by Mr. Burkill from the Galong Abors is of interest. The rubber is in the form of balls, weighing, on an average, half a pound. It is scrap rubber of fair quality and elasticity, and its composition, recorded below, is similar to that of *Ficus elastica* Roxb.

		Dry rubber.
Moisture	3·2	...
Caoutchouc	76·5	79·0
Resins	12·9	13·3
Albumen	2·6	2·7
Ash	4·8	5·0
TOTAL	100·0	100·0

The sample corresponds in analysis and appearance with some hill rubber received in 1904 from Nazira, Sibsagar.

Ceara rubber.—About nine years ago plants of ceara rubber (*Manihot Glaziovii* Muell.-Arg.) were planted out in farm land at Nahpa in the Northern Shan States. In three years they attained a height of 15—20 feet and girths of from 18 inches to 2 feet. Last year the trees were 2 to 3 feet in girth, and had grown vigorously. The latex was collected by tapping the trees by the herring-bone method in September, and about 2 lbs. of dry smoked rubber per tree was obtained at a cost not exceeding Re. 1 per tree. The cultivation thus promises to be very profitable in large areas such as the worked-out Taungyas at 2,400 feet

and below. A cake of the prepared rubber had the following composition:—

	—	Dry rubber.
Moisture	5·20	...
Caoutchouc	70·48	74·3
Resins	6·90	7·3
Albumen	13·62	14·4
Ash	3·80	4·0
TOTAL	100·00	100·0

This is fair average composition; the high amount of albumen is peculiar to ceara rubber.

Euphorbia gum.—The latex of the Euphorbias yields an inferior caoutchouc or gutta-percha, and samples are occasionally submitted for valuation. The coagulum obtained by heating the milk of *E. neriifolia* L. which had been preserved in a bottle for some years, had the following composition:—

	—	Dry.
Moisture	17·30	...
Caoutchouc	7·23	8·7
Resins	71·90	87·1
Albumen	1·87	2·2
Ash	1·70	2·0
TOTAL	100·00	100·0

A substance of this character, containing so much resinous substance, would have very little commercial value.

Mulberry gum.—The gum of the Indian Mulberry (*Morus indica* L.) has been noticed by a few observers, but no account of its properties or uses appears to exist in the literature of Indian products. A sample of the dried latex was received from the Tista Division in 1909.

When washed in hot water, a soft, white, plastic, gutta-like substance was left. It consisted largely of amorphous and crystalline resins soluble in alcohol according to the following proportions:—Moisture 4·7, resins 87·6, gutta 7·7.

Calophyllum resin.—A greenish resin is exuded by various species of *Calophyllum,* and the Indian Museum possesses two specimens from Burma and one from Madras, the production of *C. Inophyllum* L. This resin is supposed by some authorities to be East Indian Tacamahac or the "Tacamahaca orientale" of early writers, but there is no evidence that the resin is a commercial article at the present time. The resin is not known to have any industrial use, but as it is occasionally collected by the natives it is probable that they attribute to it some medicinal virtues.

The crude resin is usually mixed with pieces of bark and wood, and the purified resin is greenish, transparent and sticky, having a peculiar odour of melilot or coumarin. Two samples of the refined resin had the following constants:—Acid value, 190·9, 194·3; saponification value, 204·3, 206·7; iodine value, 148·8, 165·2.

Mesua resin.—The iron wood tree (*Mesua ferrea* L.) belongs to the same natural order as *Calophyllum,* and yields a resinous juice when the bark is bruised. A tenacious resin also exudes from the base of the young fruits and in time completely covers them. The resin is at first soft but hardens on exposure to the air; it is pleasantly aromatic. The soft resin had the following constants:—Acid value, 121·3; saponification value, 143·4; iodine value, 124·8. 61 per cent. of a hard brown acid resin was separated from the total; this had an acid value of 190. The unsaponifiable portion was fluid and balsamic.

Tibetan lac.—Dr. G. D. Hope, of the Indian Tea Association, presented to the Museum a sample of brown resin from Kalimpong having the properties of crude lac. According to Tibetans the incrustation is produced on the branches of trees of which one is "Siris" (*Albizzia Lebbek* Benth.). They boil the resin with water and prepare a red dye which they use for dyeing their clothes. The residue is pressed into cakes or sticks and sold in the bazaars. It is called "Laha" in Kalimpong, and is used for various purposes, such as fastening khukri handles and other articles. The lac is also brought in by Bhuteas to the annual cold weather fairs at Dananga and Subankhata in the north of the Kamrup district. Similar cakes are known in Manipur where they are called "Cha." The resin had the characteristics of crude lac with 10·5 per cent. of insoluble impurities.

Messrs. Hoseason and King have contributed to the Society of Chemical Industry a preliminary note on the examination of various samples of stick lac and shellac from Calcutta.

Sterculia gum in tragacanth.—The substitution and adulteration of powdered tragacanth with a substance known to trade as Indian gum has of late assumed large proportion, and enquiries have been made as to its occurrence. True tragacanth is a product of Turkey, Asia Minor and Persia and is exported from Beirut and the Persian Gulf ports. Mr. H. C. Fuller has shown that *Sterculia urens* Roxb. is the source of the substitute for tragacanth, and is supplied from India, where it is used in place of tragacanth in the hospitals in Bombay. The spurious article forms a nearly transparent jelly with water, and the aqueous solution is decidedly acid to litmus paper. It is unaffected by iodine solution which becomes blue in the presence of tragacanth, and it does not give a yellow colour when boiled with alkali. Indian gum reacts in a peculiar manner with borax. Tragacanth gives a smooth creamy mixture, while the substitute gives a thick slimy mass, often so gelatinous that it will not pour out of the container. Another important property of the new gum is the separation of volatile acids, largely acetic, on boiling with mineral acids. The amount of acid given off by specimens of Sterculia gum is quite constant and the acidity of a sample under examination will furnish a very reliable figure for estimating the amount present.

W. Schirmer of Strassburg has investigated the gum of *Anogeissus latifolia* Wall. and *Odina Wodier* Roxb., received from the Indian Museum, and has studied the products of their hydrolysis. Anogeissus gum contains half its weight of Arabo-galactan in which araban predominates. Odina gum contains half its weight of Arabo-galactan in which galactan predominates. Anogeissus gum yields 0·95 per cent. of nitrogen, and the Odina gum 0·78 per cent.

II.—Fixed and Volatile Oils.

Bassia seeds.—Samples of these seeds were forwarded to the Imperial Institute by the Reporter on Economic Products and have been examined by Mr. R. G. Pelly. *B. butyracea* Roxb. seeds are richer in fat than those of either *B. longifolia* L. or *B. latifolia* Roxb.: *B. butyracea* yields 61·2—66·9 per cent.; *B. longifolia* 55·3—57·8 per cent.; and *B. latifolia* 33·0—46·0 per cent. of fat.

The fats of *B. longifolia* and *B. latifolia* are of similar character, but they differ widely from the fat of *B. butyracea*. This is confirmed

by the results of the investigation of the fatty acids, which, stated briefly, are as follows. The fats of *B. longifolia* and *B. latifolia* consist of glycerides of stearic, palmitic and oleic acids, and in the case of *B. longifolia* of linoleic acid, whilst the fat of *B. butyracea* contains glycerides of palmitic and oleic acids only. The fat of *B. butyracea* is of firmer consistence, and this fact, together with the superior yield obtainable, indicates that the seeds of this species are of greater value than those of other species if it is found that supplies can be obtained in sufficient quantity for the European market.

Marotti fat.—In 1911 it was recorded that several poisoning cases had occurred in Germany through the consumption of margarine made from "Marotti" or Maratti" fat or "Cardamom" oil imported from India. An investigation made at the Hamburg Hygienic Institute showed that the fat is very similar to that yielded by *Hydnocarpus Wightiana* Bl. and *H. venenata* Gaertn. of South India and by *Taraktogenos Kurzii* King, the Chaulmugra of North-East India. This discovery has been the subject of numerous reports and enquiries. All these fats contain chaulmoogric and hydnocarpic acids, which are now shown to be physiologically active, causing nausea and vomiting and producing irritation of the mucous membrane of the stomach.

Gynocardia oil.—The rancidity, judged by the high acid value of commercial samples of Chaulmugra oil, is attributable to the decomposed state of the seeds before they are pressed. A much superior oil, it is presumed, would be obtained from fresh seeds or seeds preserved after careful drying. In order to test the property of the oil from newly collected and carefully picked seeds, some seeds of *Gynocardia odorata* Br. or False Chaulmugra were forwarded by Mr. Burkill from Kobo, the base of the Abor Expeditionary Force. The acid value of the ether extracted oil was 3·23, that of the expressed oil 3·09. We may compare these figures with those of Power and Barrowcliff obtained on the oil of the same seeds collected in the ordinary way and examined after a long sea voyage. The determinations recorded are—Acid value of ether extracted oil, 5·0; expressed oil, 4·9. The acid values of the oil of the fresh seeds are not much below those determined in England, but they are lower than all the published acid values of Chaulmugra oil of commerce, and the results tend to prove the desirability of using seeds fresh as possible for oil extraction.

Chilgoza nuts.—The seeds of Chilgoza or Neoza pine (*Pinus Gerardiana* Wall.) form one of the great trade products exported from the district of Khost and the Kuram Valley to India. Large quantities also

pass through Leh to Yarkhand and Lhassa. They are sold all over Northern India, and are available in the Calcutta market in the dry weather. The nuts form a nutritious article of food, and the oil is sometimes expressed and used for edible purposes. The nuts contain about half their weight of oil which is almost neutral in reaction and possesses slightly drying properties.

Thevetia seeds and oil.—Under the name of "Kaneer" the Chemical Examiner of the United Provinces forwarded some seeds which had been used in cattle poisoning. They were identified as the seeds of the yellow Oleander (*Thevetia nereifolia* Juss.). All parts of the plant are known to be poisonous, and the active principle, thevetin, has been shown to resemble digitalis in its action. In addition to their morphological characters the seeds are easily distinguished by giving a blue colour with hydrochloric acid.

The seeds are very oleaginous, and a sample from Dacca had the following composition:—

Moisture	3·5
Oil	59·8
Albuminoids	16·5
Carbohydrates	17·1
Fibre	·4
Ash	2·7
TOTAL	100·0

The oil is perfectly liquid at ordinary temperatures and has a specific gravity of 0·9148 at 25° C. Oudemans found it to consist of 63 per cent. triolein and 27 per cent. tripalmitin and tristearin.

Prinsepia utilis Royle.—The seeds of this shrub, known as "Bhekul," yield an oil by expression which is used in the North-West Himalaya for food, illuminating, and occasionally in medicine. It is said to be exported in small quantities from the forests of Garhwal and Kumaon. There are two samples in the Indian Museum: one from the Kangra Valley, of a bright green colour, and the other from Bushahr in the Punjab, opaque and light brown in colour. In specific gravity, iodine value and melting point of the insoluble fatty acids, the oil resembled that derived from cotton seed.

An Agricultural Ledger on fixed oils has been published during the year by Mr. Hooper. It deals with the sources, properties, uses and value of vegetable fats and oils available in British India.

Cinnamomum glanduliferum Meissn.—The "Nepal Sassafras" or "Nepal Camphor" occurs as a large tree in Assam, where it is called "Gonserai." The oil of the wood examined by Mr. S. S. Pickles is pale yellow and possesses an odour resembling safrole. The yield obtained from the dried ground wood by steam distillation was 4·16 per cent. An exhaustive examination showed the oil to consist mainly of safrole, myristicin and elemicin. Other constituents present in small quantities are palmitic acid, esters of the lower fatty acids and traces of phenols.

Cinnamomum Parthenoxylon Meissn.—This yields the Martaban camphor wood or Selasian wood. An oil distilled from the chips at Buitenzorg gave the following constants:—Density 1·067, optical rotation – 1° 3′, saponification value 8·4, ester value after acetylation 11·8.

Meriandra bengalensis Benth.—The leaves of this labiate plant are used in Eritrea as a popular remedy for similar purposes as those of sage, and the oil bears some resemblance to sage oil. The raw material yields 1·5 per cent. of a pale brown oil with an odour of sage and rosemary. The density was 0·9513, acid value 3·7 and ester value 14·8. It was soluble in two volumes and more of 70 per cent. alcohol. Placed in a freezing mixture or submitted to fractional distillation dextrorotatory camphor was separated.

Ocimum sanctum Linn.—The statement that the oil of the Holy Basil of India contains methylchavacol has been confirmed. Brooks, who has recently investigated the product in the Philippines, found between 50 and 60 per cent. of methylchavacol, besides cineole and linalool.

Strobilanthes lupulinus Nees.—A fragrant acanthaceous shrub very common on the ghats near Bombay is collected for its perfume. The oil distilled from the flower buds possesses a very strong and pleasant odour. The constants are: Density 0·9648, optical rotation 16° 30′, saponification value 1·7, and ester value 25·7.

Indian turpentine oil.—In continuation of the remarks made on this oil in last year's report, Mr. H. H. Robinson has examined by fractional distillation and analysis genuine samples of the oil of *Pinus longifolia*. One fraction, amounting to about one-third of the whole, was of a much lower boiling point and was found to be l-pinene. From the remaining two-thirds sylvestrene was obtained as a hydrochloride. It is thought very possible that the sylvestrene is not present as such in the original oil, but that a terpene is there contained which unites with hydrogen chloride to form sylvestrene dihydrochloride, just as pinene

yields a hydrochloride from which camphene is obtained when the hydrogen chloride is removed.

Toddalia aculeata Pers.—A camphor-like compound melting at 96·5° to 97° has been obtained by Mr. B. T. Brooks from the oil. The leaves yield ·08 per cent. of oil by steam distillation. On freezing, the oil deposited 18 per cent. of a white crystalline compound, very volatile, and having an odour closely resembling that of camphor. The oil had an odour suggesting a mixture of camphor and lemon grass. Sp. gr. at 20°, 0·9059. The oil is largely linalool, since the fraction between 195° to 200° yielded citral on oxidation with chromic acid mixture.

Indian Wintergreen oil.—The parent plant of this oil is *Gaultheria fragrantissima* Wall., a bush occurring gregariously over tracts of the Nilgiri Hills and the Palni and Travancore Hills. It differs markedly from the American Wintergreen (*G. procumbens* L.) which is a small creeping shrub. The oil consists chiefly of methylsalicylate, and that distilled locally is wholly restricted to home consumption. It would, however, be possible to extend the industry seeing that there is abundance of the raw material available.

III.—Dyes and Tans.

Cedrela Toona Roxb.—These flowers which constitute an Indian dyestuff of minor importance yield, according to Mr. A. G. Perkin of Leeds, a minute amount of a red colouring matter identical with the nyctanthin obtained by Hill in 1907 from the flowers of *Nyctanthes Arbor-tristis*. This melts at 285—287°. In dyeing and other properties it closely resembles, but is not identical with, the bixin of annatto (*Bixa Orellana*). The presence of quercetin contaminated with a trace of an allied colouring matter as glucoside and of a sugar have also been detected, and to the former the main dyeing properties of the flowers appear to be due.

Red Sandal Wood.—Santalin, the colouring principle of Red Sandal Wood (*Pterocarpus santalinus* Linn. f.), has been examined by Messrs. Cain and Simonsen. Santalin is a red micro-crystalline powder melting at 276°, and having the formula $C_{15}H_{14}O_5$. It contains a methoxy and two hydroxy groups. With hydroxylamine it forms an oxime, and on oxidation with potassium permanganate yields veratric and anisic acids. The authors isolated a colourless glucoside from the sap of the plant, from which santalin is probably produced in the plant by the action of an oxidase.

Assam dye wood.—The root of the "Napoo" (*Fibraurea Trotteri* Watt), an extensive climber common in the forests of Manipur, is used as a yellow dye in Assam. The root is soaked in water, cloth is steeped in the infusion for twenty-four hours, and the colour is fixed by means of the fruits of "Heibong" (*Garcinia pedunculata* Roxb.). An authentic sample of the root was analysed and found to contain 1·89 per cent. of the alkaloid, berberine.

Mangrove bark.—A large quantity of the wood of the "Goran" (*Ceriops Candolleana* Arn.) is brought from the Sunderbans into Calcutta for fuel. The bark is a valuable tanning material, but it is said to vary according to the age of the tree from which it is taken. In order to determine the distribution of tannin in the older and younger bark, a tree about 12 feet in height was cut down and divided equally into four parts, the first representing the thicker and older bark at the base of the stem, and the fourth representing the thinner and younger bark at the top. The bark from each portion was separately dried and analysed with the following results:—

	Moisture.	Ash.	Extract.	Tannin.
No. 1	11·3	9·5	37·2	26·2
No. 2	11·0	9·0	36·7	24·6
No. 3	10·5	8·8	35·4	23·8
No. 4	10·5	8·9	34·7	22·8

This experiment exemplifies the greater tanning value of the older and thicker bark of the mangrove tree compared with the younger portion.

IV.—Fibres.

Rhea.—At least two processes for cleaning rhea fibre (*Boehmeria nivea* Hook. & Arn.) in India have been devised during the year. A Calcutta merchant submitted samples along with samples of the fibre prepared in Germany for favour of comparison with that prepared locally. In appearance they were equally good and in strength they were about the same. On testing them by chemical methods, there was found to be a very little difference in their composition. A cheap and suitable plant for cleaning the fibre on a large scale is still desirable.

Hental leaves.—An enquiry has again been made as to the value of the leaves of "Hental" (*Phœnix paludosa* Roxb.), the wild date palm of the Sunderbans. The leaves contained 28·6 per cent. of cellulose. Some years ago a large quantity of the leaves was sent to a paper mill

for experiment, and the manager reported that the yield of fibre was only 25 per cent., and the material was therefore too expensive to use.

The bark of "Bhola" (*Hibiscus tiliaceus* L.), a plant of the Sunderbans, yielded 30 per cent. of fibre. The bark of *Sterculia villosa* Roxb. affords 49·85 per cent., a much better return.

V.—Food Substances.

Amorphophallus tubers.—The corms or tubers of *Amorphophallus campanulatus* Bl. are cultivated throughout India in rich moist soils. In Bengal the plants are known as "Ol," and the roots, containing much starch, are considered nutritious and wholesome, and are cooked like potatoes by boiling or roasting. The wild roots are acrid and irritating, which property is removed by thorough washing and boiling. The acrid principle is partly, if not entirely, due to the presence of needle-shaped crystals or raphides, which causes troublesome irritation in the mouth and fauces. Four samples of fresh tubers of the following descriptions were analysed to ascertain their nutritive value:—

(1) "Deshi Ol," cultivated, with fingers; (2) "Chit Ol," a wild small tuber; (3) "Deshi Ol," large, cultivated; (4) "Bombai Ol," large, cultivated.

The dried and powered tubers contained from 0·7 to 1·2 per cent. of fat, 6·7 to 9·6 per cent. of albuminoids, 80·3 to 85 per cent. of carbohydrates, 2 to 3·8 per cent. of fibre, 4·7 to 7·5 per cent. of ash, and 0·55 to 0·75 per cent. of phosphoric anhydride.

The samples were examined microspically and raphides were found most abundant in the wild variety (No. 2) containing the largest amount of ash. The largest quantity of lime as acid soluble ash was also present in this tuber.

Bamboo seed.—Owing to the phenomenal flowering last May of the Muli bamboo (*Melocanna bambusoides* Trin.), in Assam, the large pear-shaped fruits have attracted attention. Dr. Stapf has described the fruit in the Trans. Linnean Society, 1901-5, VI, 409. They are said to be edible, but no chemical analysis has so far been made of them. A sample was sent by Messrs. Shaw, Wallace & Co. from one of their estates in Sylhet. The edible portion or seed is quite palatable and had the following percentage composition:—

Moisture 10·20, fat ·65, albuminoids 14·62, carbohydrates 65·23, fibre 1·40, ash 7·90, phosphoric anhydride ·69.

Salep.—There being very few recorded analyses of salep, the dried corms or tubers of species of orchids, a sample of the large ovoid roots obtained from Lahore bazaar in 1908 was examined. The powder had the following composition:—

Moisture 9·65, albuminoids 8·62, carbohydrates 77·73, fibre 1·15, ash 2·85, phosphoric anhydride ·56.

VI.—Accessories to Human Food.

Tea.—Dr. G. D. Hope and his assistants have continued their investigations into the various problems affecting the tea industry, and the results have been published in special reports and in the new Quarterly Journal of the Scientific Department. In a paper on the "Firing of Tea" (No. 1 of 1911 of the Indian Tea Association) Messrs. Hope and Carpenter describe the results of experiments carried out at the Heeleaka Experimental Station. Changes in the amount of tannin, total soluble matter and oxidisable volatile matter in the leaf as the result of firing under different conditions are recorded, and the inference is drawn from the indications afforded by the experiments that it is most detrimental to the successful retention of essential oil, tannin and total solids to fire it at a high temperature during the early stages of the process, particularly if the leaf is surrounded during that time by an atmosphere highly saturated with water vapour. It appears more desirable to effect the drying in as short a time at a lower temperature by means of an increased air draught and the leaf thinly spread on the trays of the machine. There are indications of chemical changes taking place at the later stages of, and after firing, which may profoundly influence the flavour of the product.

In the second Quarterly Journal of the Department there is an interesting article on caffeine, describing the distribution of the alkaloid in the organs of the tea plant, the amount present in teas of various kinds and the combination of caffeine and tannin in the infusion.

Abor tea.—In May last Mr. A. J. Harrison of Dibrugarh, Assam, sent to the Indian Museum some specimens of leaves which the Abors call tea, and from which they make an excellent drink. The plant is about 5 feet high, and grows near the villages. The plant has been identified as *Actephila excelsa* Muell., a plant of the *Euphorbia* family. The leaves contain no alkaloid and are without any special aroma. They are extremely mucilaginous. A small quantity of tannin was present

and a white crystalline neutral principle. They would appear to constitute a harmless drink.

Bee-food.—The flowers of certain species of *Strobilanthes* growing in the Bombay Presidency and in Burma are visited by the large Indian bee (*Apis dorsata*) for collecting honey and wax. The flowers are aromatic, and the sticky sweetly scented buds of *S. ixiocephalus* Benth. are sent to Bombay from Kathiawar as a perfume. Some of the dried flower heads of *S. foliosus* T. Anders. were sent to the Museum for examination, to ascertain if the resin could be put to any commercial use. In addition to 9 per cent. of a fragrant oleo-resin, the heads afforded 3·18 per cent. of wax and 0·5 per cent. of sugar. The wax and sugar, no doubt, contribute largely to the bee-food found in the jungles in the Bombay Presidency.

Alcohol.—Mr. R. L. Jenks, formerly of the Central Excise Laboratory, Kasauli, has in the press a report on the method of spirit valuation for revenue purposes, and has devised a suitable pycnometer for taking the specific gravity of alcohol in the tropics at 60° F.

VII.—Medicinal Products.

Camelthorn root.—A sample of the root of camelthorn (*Alhagi camelorum* Fisch.) was sent from Cawnpore to the Indigenous Drugs Committee for examination and report, it having been pronounced to be a specific in malaria. The root contained a wax, resin, tannin, tannin anhydride, organic acid, sugar, quercetin, and colouring and mucilaginous matters. It yielded no alkaloid. Its properties being mildly astringent, the root would appear to have no recommendation as a febrifuge.

Belladonna leaves.—The acclimatisation of medicinal plants is a subject worthy of further study in this country. It is intended to prepare a statement of those that are cultivated for the Medical Stores and compare their composition with plants grown in Europe. A sample of leaves of *Atropa Belladonna* L. grown in Kashmir and sold by a Calcutta druggist was sent for valuation. The leaves contained 0·27 per cent. of alkaloid, an average yield compared with the European drug.

Belladonna root.—The Superintendent of the Kumaon Government Gardens forwarded for opinion the roots of Belladonna plants grown at Jeolikote—No. 1 sample was from one-year old plants, and No. 2 sample was from two-year old plants. They afforded respectively 0·40 and 0·45 per cent. of alkaloid. A sample from Kashmir also gave 0·45 per cent. The valuation of European root is from 0·2 to 0·6 per cent. of

alkaloid; the cultivated Indian root is, therefore, of average medicinal quality.

Coptis root.—The two sources of this root procurable in India are the Mishmi Teeta from the Mishmi Hills, north-east of Assam, and the root imported in Bombay from Japan. The former is considered a superior drug and commands a higher value in the market. A description of the two kinds known in this country and the result of their comparative analysis has been published as a supplement to Mr. Burkill's work on the botany of *Coptis*.

Croton bark.—It has been reported that the bark of *Croton Tiglium* L. is one of the ingredients of the Abor arrow poison. The bark is intensely acrid, and when applied to the arm in a fresh state it causes irritation and raises pustules. Two preparations were made from the bark, one a watery extract, and the other an alcoholic extract. The extracts were examined by Major J. W. D. Megaw, I.M.S., of the Medical College, Calcutta, with a view to finding the minimum lethal dose on guinea-pigs. 0·63 gram of the watery extract inserted in a pocket under the skin produced marked local irritant symptoms and caused death in five days. 0·2 gram of the alcoholic extract injected subcutaneously caused death in four hours. 0·1 gram caused death in 28 hours. Both cases were attended with marked local irritation. The extracts are of a comparatively low degree of toxicity for guinea-pigs, but the experiments prove that the fresh bark contains a poison of distinctly virulent type.

Gardenia gum.—The Deputy Conservator of Forests, Ramnagar, Garhwal Division, United Provinces, sent last June some samples of a white incrustation taken from trees of *Gardenia turgida* Roxb. The exudation occurred after longitudinal cuts had been made in the upper part of the stem, and did not form at the base of the tree. The gum was white, brittle and sweetish to the taste, and on testing its solubility and melting point it was found to contain mannite. The occurrence of manna in this genus is remarkable since other species of *Gardenia* are known to yield a yellow fragrant resin, called Dikamali resin.

Ginger.—In testing some samples of cultivated ginger root it was necessary to traverse the statement made by S. J. Riegel in 1891 that East Indian ginger yields 8 per cent. of oleo-resin, and that Jamaica ginger contains about 5 per cent. It was found that on estimating the pungent resinous principle by means of alcohol, either of 90 per cent. strength or absolute, the dried extract contained sugar and other matters soluble in water. The amount of washed oleo-resin would therefore be a more accurate criterion of the value of the root. A few Museum samples,

and recently dried samples from the local market, were extracted with strong alcohol, and the extracts washed with water. The following results were obtained:—

	Alcoholic extract.	Washed resin.
Punjab	11·1	8·1
Rough, Calicut	9·3	7·0
Bleached, Calicut	6·0	4·0
Unbleached, Calcutta	5·7	5·1
Bleached, Calcutta	5·1	4·6
Freshly dried, Geoukhali	8·4	3·9
„ „ Hooghly	7·9	4·3
„ „ Rungpur	11·8	5·1
„ „ „	9·3	4·7

From these few examinations there is seen to be a great variation both in the amount of extract and oleo-resin. The freshly dried samples also contain a smaller proportion of resin in the extract than the Museum samples of dried ginger.

An interesting experiment was made in the Kumaon Government Gardens to ascertain if ginger increased in value by being left longer in the ground. The root is usually harvested in December, and for purposes of the trial a sample was collected that month, another portion of the crop was lifted in February, and a sample of the original "Soont" from which the younger roots had grown was also taken. These were analysed:—

	Harvested in December 1911.	Harvested in February 1912.	Original "Soont."
Extract	6·4	8·3	14·0
Washed resin	3·0	3·5	4·1
Ash	6·5	6·8	7·2
Moisture	11·1	10·4	9·7

These results demonstrate that young ginger develops more oleo-resin the longer it is allowed to grow.

Saffron.—The Revenue Commissioner in Baluchistan forwarded during the year to the Reporter on Economic Products a sample of stigmas and anthers of *Crocus sativus* L. cultivated experimentally in Quetta. The stigmas, which constitute the true saffron of commerce, were of excellent quality, both in aroma and tinctorial properties.

Indian blistering beetles.—*Mylabris cichorii* Fabr. and other species of this beetle have been used for many years as a substitute for European cantharides, and are official in the Indian and Colonial addendum to the British Pharmacopœia. The beetles are collected for commercial purposes at Gwalior, and are supplied to all the Medical Store Depôts. K. Dieterich in 1901 found these beetles to contain from 0·73 to 1·92 per cent. of cantharidin, while the Spanish flies yielded on an average 0·7 per cent. Eldred and Bartholomew in 1908 recorded the occurrence of 1·24 and 1·36 per cent. in Mylabrideæ. During the year samples have been obtained from the principal Medical Store Depôts and submitted to analysis. The following figures were obtained:—

	Cantheridin.	Ash.	Moisture.
Calcutta	1·47	8·7	11·0
Bombay	1·02	5·7	10·2
Lahore	1·26	5·3	7·7
Madras	1·12	7·2	10·5

This result is satisfactory in showing that the drug used in India contains over 1 per cent. of cantharidin. The dried beetles do not appear to lose their active principle on being stored. The sample from Calcutta was marked as "old stock, 1910," yet it contained the largest amount of active principle.

There is evidence that the amount of vesicating principle depends upon the species of beetle employed. A sample of *Cantharis hirticornis* from the Murree Hills, Punjab, yielded as much as 2·02 per cent. of cantharidin.

Indian hemp.—Messrs. C. R. Marshall and J. K. Wood have submitted to the Therapeutic Sub-Committee of the British Medical Association a report on the standardisation of Indian hemp (*Cannabis sativa* L.). This is an investigation of the value of the acetyl number

which a previous research had indicated as likely to offer the basis of a chemical and physical standard. Many acetyl numbers were determined, but it was found that there is a marked divergence between the pharmacological activity and the acetyl number which indicates that this method, like the iodine value reported on last year, cannot be used as a substitute for physiological standardisation.

Ægle Marmelos Corr.—Mr. J. C. Shenstone has recorded the interesting observation that bael fruit contains starch granules of a peculiar shape. It is unusual to find starch in a fruit which develops rapidly to ripeness and then decays. The starch may be deposited to provide nourishment for the fruit in the final effort of ripening.

Andrographis paniculata Nees.—By extracting the leaves of this bitter medicinal plant with alcohol, M. K. Gorter has isolated a lactone, $C_{20}H_{30}O_5$, named andrographolide. It is converted into salts of andrographolic acid by boiling with caustic alkalis.

Cæsalpinia Bonducella Fleming.—The seeds yield an alkaloid for which Babu K. Bhaduri suggests the name "natin." The oil has a density at 27° of 0·9132, iodine value 96·1, and saponification value 292·8.

Cinchona.—During the past year in the Bengal Cinchona Plantations 853,638 lbs. of bark were worked up in the factory and yielded 48,393 lbs. of sulphate of quinine and other products. The plantation-grown bark yielded 3·4 per cent. of quinine and the imported Java bark yielded 5·7 per cent. To obtain a rough idea of the future yield of the Munsong Cinchona, 27 trees gave 324 lbs. of dry bark, equal to 12 lbs. per tree. The stem bark yielded 5·25 per cent., root bark 4·92 per cent. and branch bark 2·89 per cent. of sulphate of quinine or an average of 4·71 per cent.

In the Madras Cinchona Plantations in the Nilgiris 755,900 lbs. of bark were worked up in the factory and yielded 30,489 lbs. of quinine sulphate or 4·03 per cent. against 3·63 per cent. in the previous year.

In connection with this subject a translation has been published in the form of an Agricultural Ledger of Dr. K. W. Van Gorkom's administration of the Java Cinchona Estates during the period from 1872 to 1907.

Daturas.—Mr. A. E. Andrews has studied the active constituents of Indian solanaceous plants. It was found that in *Datura Stramonium* L. the percentage of total alkaloid in the stems was 0·25; in the leaves 0·41 and 0·45; and in the fruits 0·46; with one exception this alkaloid consisted of hyoscyamine either alone or associated with a small proportion of scopolamine. The results indicate that the Indian plant bears

favourable comparison with the European and Egyptian plants as regards the amount of total alkaloid, but the presence of scopolamine in some of the Indian samples appears to be a point of difference.

In *D. fastuosa* L. the total alkaloid varied from 0·1 in the roots to 0·2 in the fruits, and scopolamine was found to be the predominant alkaloid. In these respects the Indian plant closely resembles the European plant.

In *D. Metel* L. the seeds and the leaves contained 0·25, and the capsules 0·12 per cent. of total alkaloid. On comparing the results with those recorded for the European species it appears that in the Indian plant the amount of total alkaloid in the seeds and in the leaves is only about one-half what it is in the European plant, but with one exception the samples resemble the latter in so far that scopolamine is almost unaccompanied by other mydriatic alkaloids.

Nerium Oleander L.—Further investigations by A. Leutier confirm the existence in all parts of the plant, except in the latex, of the glucoside previously reported. This is probably the substance named "neriin" by Schmiedeberg who examined the plant in 1883 and isolated, besides this, the alkaloid oleandrine, and another glucoside, neriatin. On account of its strong affinity to strophanthin, neriin is now re-named "laevostrophanthin." A solution of a few crystals of the glucoside in strong sulphuric acid is coloured violet by contact with bromine vapour or nitric fumes. It is very poisonous, the toxic dose ranging from 2 to 6 mgm. per kilo for the dog. The latex contains another distinct crystalline glucoside.

Vernonia anthelmintica Willd.—The seeds contain a glucoside to which Babu K. Bhaduri has assigned the name "Shomerajin." The oil has density at 25° of 0·9731, iodine value 91·7, saponification value 305·7.

PART II.—AGRICULTURAL CHEMISTRY.

BY

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Usar Soil.—A long investigation which has been in progress in collaboration with officers of the Agricultural and Irrigation Departments for several years was brought to a conclusion during the past year. In the

United Provinces "alkali spots" occur in cultivated lands over a very large area. These spots are more or less infertile, frequently quite sterile, patches of land of a few square yards in area. Sometimes they lie so close to the margin of an usar plain that the relationship of the one to the other is apparent, but often such connection is absent. They occur alike within canal-irrigated and well-irrigated lands. Sometimes complaints are made that an extension of these alkali spots has occurred and it was due to such a case of complaint that the series of investigations now referred to were instituted.[1]

The first questions raised were to what extent do the usar salts move either vertically during changes of season, or laterally. It has been generally accepted as an established fact that the obnoxious soda salts of alkali lands are brought to the surface by the evaporating water during dry weather and are carried into the sub-soil during wet weather; that in fact such a movement is not only to be expected on theoretical grounds, but that such a periodical displacement applies to a large proportion of the saline ingredients in the soil. It is also certain that such salts will spread laterally into any soil which contains a less quantity, not that there is necessarily any movement of water, but the laws of diffusion of salts demand that this must be so.

But whilst the principles involved are readily defined, the practical effect on the land will depend on the amount of such movement in a given time. If it is great, as writers on alkali soils usually depict, the effect will be marked; on the other hand it may be so small as to be of no importance.

The tests which were made in order to estimate the amount of such movement of salts were carried out in the Mainpuri District near Bhadan by the late Babu Subodh Chandra Kar, second assistant to the Imperial Agricultural Chemist, under instructions from Mr. B. C. Burt and Dr. Leather, and the results went to show that the variation at any one time in the quantity of these salts from point to point in a horizontal plane in the soil was so great that it would only be possible to detect a seasonal movement of salts if this were considerable. The tests were conducted over a whole cold-hot weather season, November 1909 to May 1910, and necessitated the examination of the soil at each succeeding 6 inches from the surface down to either the water-level or to 9 ft. It was shown that no measurable movement of the alkali salts occurred in these soils towards the surface during the dry season. There was also no indication of any

[1] See "Investigations on usar land in the United Provinces" (*in the press*).

saline layer, so often spoken of as a characteristic of alkali lands in general, in the sub-soils at any time. The salts included the very destructive sodium carbonate, and bicarbonate, together with generally smaller amounts of chloride and sulphate; the amount of alkali though small was sufficient to account for the infertility of the soil. Records of the amount of water present throughout the season showed that there was a far smaller loss of this constituent than would occur in good arable land.

These soils were at the same time examined with regard to another characteristic, namely, their permeability to water, or the rate at which water moves through them. It was known in a general way that many of these alkali soils are much less permeable to water than ordinary agricultural land, but for the end in view a quantitative measurement became essential. There being no recognised method of making such a measurement, a new test had to be devised. This was done at the Pusa laboratories. The test consisted in first packing the soil into cylinders fitted with a "false" bottom by the aid of a specially designed machine, and then allowing water to percolate through it. It proved of the utmost service and showed that the permeability of these alkali soils to water was far less, one-hundredth or one-thousandth part, than in good arable soil.

This feature of the soil provided the true explanation of the facts which had been observed in regard to the salts. The movement of the salts is dependent, excepting in respect of diffusion, on the movement of water through the soil. If this is small, so will be the amount of salts which can move through a given stratum of soil in a given time. The soils were in fact so highly impervious to water that there could be no material movement either downwards during wet weather or upwards during the dry season, and there was consequently no "saline sub-soil layer" during the monsoon, nor accumulation of salts on the surface in the hot weather. The *appearance* of these lands gives the impression that such changes do occur, because in dry weather the salts dry on the surface and become visible, but in point of fact they are merely carried by rain about an inch or so into the soil where they remain practically stationary until the dry season sets in.

Subsequently to the above-mentioned investigation, a large number of alkali spots were examined (1910-11) through a stretch of about 20 miles of country in the Muttra and Etah Districts with a view to ascertain whether any difference exists in the nature of these alkali spots in well-irrigated and canal-irrigated tracts respectively. The first 10 miles

consists of country which has never been canal-irrigated but always well-irrigated; the second 10 miles has been under canal-irrigation for many years. In addition to general appearances and the character of the crops, samples of the soils were drawn, as had been done in Mainpuri District, for each succeeding six inches from the surface down to 9 ft. and examined with respect to the nature and amount of salts present and their physical properties. The results showed very conclusively that there is no difference between these alkali spots which are found under the two systems of irrigation; in every respect they were similar. They are not therefore the creation of canal-irrigation. They consist of "blocks" of an irregular shape both below and on the land surface; in superficial area they measure a few square yards, in depth rarely more than 9 ft. but usually more than 5 ft.; the side is often apparently nearly vertical but also commonly slopes away; nodular kankar frequently occurs in them but is probably not a necessary constituent, since it was apparently absent in some cases. The soil is highly impervious to water; the amount of salts is usually small, but the pernicious sodium carbonate is always present. No ordinary system of drainage could hope to affect such soil. Approximate calculation showed that if 2 ft. depth of water were constantly maintained on the surface of such land, the time required for it to percolate through 5 ft. would be from 6 months to 5 years according to the exact nature of the land.

The experiments which have been in progress on usar land at Aligarh for a long time were also examined. There the land is a compact alkali plain, the soil of which has the same general chemical and physical characteristics as have been described above, though the depth of the impervious soil is often only small, such as 3 to 4 ft. The imperviousness explains much of the small success which has attended these experiments. For example the salts had been regularly scraped off the surface of one plot for nine years, until but little saline matter accumulates on the surface soil during the hot weather. The land is however still quite sterile and the analysis showed that it contains in the sub-soil practically as much salts as it did formerly. The effect of the annual scraping has been to remove that portion of the salt which was always quite near the surface and which could be brought up annually by the evaporating water, but the greater part of the salts lies too far off to come out and remains permanently buried. Another and still more interesting case is situated at Mr. Keventer's dairy farm. For many years now useful fodder crops have been grown successfully, with the aid of very liberal applications of manure and water, on land which was formerly some of the worst usar.

To the visitor this land appears to be quite reclaimed. Examination of the soil however showed that although the upper 12 to 18 inches have been rendered fertile, the soil below is as impervious and saline as at first. The cultivation is in fact carried on purely with the help of about a foot of soil. It follows therefore that irrigation must be just as frequent as would be the case were there solid rock below.

In one instance gypsum, which was applied in very liberal quantity 14 years ago, has worked its way throughout the impervious stratum and having not only destroyed the sodium carbonate but also at the same time made the soil pervious to water, this patch has been entirely changed to fertile soil, but at a cost which is quite prohibitive.

At Pusa experiments were made with pot-cultures to ascertain the effects of alkali and imperviousness when acting separately. To this end in one set of tests the alkali was almost neutralised by gypsum without however affecting the impervious character, whilst in another set the soil was rendered permeable to water by the addition of sodium chloride, used in such quantity as not to affect plant growth; the alkali would of course remain. These tests went to show that of the two characteristics of this class of alkali soil, the sodium carbonate is the more severe on plants, though the impervious state was sufficient to practically prevent plant development.

In another set of experiments, also at Pusa, soil is maintained in a very wet state at 20 inches from the surface. The option has been expressed that good arable land becomes alkali under conditions of excessive canal-irrigation which commonly implies a high water-level. For the purposes of the test some soil was dug out of two fields where crops were growing, the adjacent land being usar, the idea being that such land would be more likely to become affected than land remotely situated from alkali patches. It was packed into large stone-ware jars and water has been added to the base so as to maintain the bottom soil in a permanently wet state. At the end of two years an examination of these soils showed that one was free from any sign of becoming usar, whilst the result with the other was doubtful. This experiment is being continued.

Soils—Regur.—A very interesting addition has been made to our knowledge of the cause of the black or dark brown colour of *regur* (black-cotton) soil by Messrs. Harrison and Ramaswami Sivan.[2] They confirm the observations of Leather[3] that the black colour is only in part accounted

[2] Memoirs, Dept. Agri. India, Chemical Series, Vol. II, No. 5
[3] Agri. Ledger, No 2, 1898, p. 26.

for by the presence of organic matter, and that it is largely due to mineral matter, and they confirm also the observation of Annett[4] that these soils contain a titaniferous magnetite. At the same time an examination of regur from many parts of the Madras Presidency as well as from the Bombay Deccan and the Central Provinces showed that these soils in Madras often contained only very small proportions of magnetite or none at all, but that all these soils contained another class of dark coloured mineral.

Separations were at first made by the aid of cadmium borotungstate and Thoulet's solution, but with these it was found that the dark coloured substance was liable to disintegration, and acetylene tetrabromide (sp. gr. 2·9) diluted with absolute alcohol, proved to be more suitable. The dark coloured material was found to consist of compound particles. Its amount in these soils is considerable, varying from one-third to one-half of the coarser portion of the soil; the finest portion being excluded.

This dark coloured material has a low specific gravity. Under the microscope it is seen to consist of transparent or semi-transparent grains cemented together by a dark coloured substance. The latter is readily stained by methyl violet and is colloidal. These compound particles are readily disintegrated by pressure. They are comparatively stable in contact with strong reagents; concentrated hydrochloric acid and caustic alkali have little effect on them, though the former dissolves much iron and aluminium. On the other hand, after ignition treatment with hydrochloric acid renders them colourless. Hot concentrated sulphuric acid, however, discharges the black colour entirely, and the residue is now found to consist of white compound particles similar in shape and size to the original. The black material when wetted forms a clayey mass which dries to hard lumps. The fact that concentrated hydrochloric acid, although dissolving large quantities of iron and aluminium from the unignited material, does not remove all the black colour, indicates that this is in part at least due to organic matter. This view is also supported by the following behaviour. Treatment of the unignited material with hydrofluoric acid results in a dark coloured residue, the colour of which is not discharged by either concentrated hydrochloric acid or alkali, but it is destroyed by either hot concentrated sulphuric acid or by ignition. The authors, whilst expressing no very decided opinion, raise the question whether the cementing substance is not an organic compound of iron and aluminium.

[4] Memoirs, Dept. Agri. India, Chemical Series, Vol. I, No. 9.

Regarding the origin of regur soil the authors consider that, since these soils are found overlying not only trap, as in the Deccan, but gneisses, shales, limestones and kankar beds, and having regard to the fact that the dark colour is largely due to a cementing substance, the materials of which they consist have been derived originally from a variety of rock formations and not exclusively from trap.

Assam Tea Soils.—Results are published[5] by Dr. G. D. Hope, of a number of mechanical analyses of tea soils which have been recently carried out in the Calcutta laboratory of the Scientific Department of the Indian Tea Association according to a method which approximates to that of A. D. Hall. The mechanical composition of soils taken from different localities in the North-East Indian tea districts is described.

The soils differ so much that generalisations are difficult to make, but these analyses show that on the whole they contain commonly high proportions of clay.

Some instances are quoted which show how the proportion of fine silt in a soil is correlated to its mechanical properties and the class of cultivation required.

Indigo.—Experiments on the chemical selection of indigo (*Indigofera arrecta* Hochst.) has been continued at Sirseah, although under very great difficulties, arising from both floods and pests. Mr. Bergtheil's recent report[6] shows that the Java plant, as at present cultivated, includes two, a high and a low, indigotin yielding plants and possibly two intermediate varieties. Among other indigotin yielding plants which are being studied are *Strobilanthes flaccidifolius, Indigofera longiracemosa* and *Wrightia inctoria*. The two first named, both high yielding plants, are probably too delicate to offer much hope of successful cultivation on the large scale, but *Wrightia tinctoria* grows well and may prove of practical importance. In relation to manufacture, experiments have been made in shipping the indigo in the form of paste instead of dried cubes.

Milk.—A second Memoir on milk has been published by Messrs. Meggitt and Mann,[7] the subject now being the milk of Indian buffaloes of the Surti, Delhi, Deccani and Jaffarabadi breeds. The conclusions which the authors make may be summarised as follows:—

(*i*) The mixed milk from a herd of these cattle contains from 6·5 to 8·0 per cent. fat in the morning and from 7·5 to 8·5 per cent. in the evening, that is, they find the evening milk to

[5] Quarterly Journal, Indian Tea Association, Part I, 1912.
[6] Report of the Indigo Research Station, Sirseah, for 1911-12, by Cyril Bergtheil.
[7] Memoirs, Dept. Agri, India, Chemical Series, Vol. II, No. 4.

be the richer by about 1 per cent., a difference which is similar to what was found by these authors for cow's milk at Poona. The milk of the Surti breed was found to be somewhat richer than the others.

(*ii*) During the monsoon period the percentage of fat decreases somewhat, but otherwise the changes due to climate are nominal.

(*iii*) The solids-not-fat in the milk of the Surti breeds varies from 9·5 to 11·5 per cent., the variation for three-fourths of the samples being from 10 to 11 per cent. There is no variation in these constituents between the morning and evening milk.

(*iv*) The ratio of milk sugar : proteids : mineral matter was found to be 6 : 5 : 1; which is the same as was found formerly by Leather.

(*v*) There seems little relationship between the composition of milk of individual animals of the *Surti* breed and the yield, except that the milk becomes *slightly* richer at the extreme end of the period of lactation. Apart from this, the milk yielded by a single buffalo does not seem to vary according to the amount of milk it is giving.

(*vi*) There is very great variation in the composition of the milk of individual animals of one breed, and also between the same buffalo at various times. This last variation in the quality yielded by one animal is much greater than that previously found for Indian cows. The variation in the content of "solids-not-fat" with one animal is practically as wide as for the whole of the animals examined.

(*vii*) The average length of the period of lactation for the *Surti* buffaloes is 53 weeks, but this varies very much, from 32 weeks to 67 weeks.

(*viii*) The yield of milk from a buffalo during the lactation period rises to a maximum almost at once, and remains almost constant for about the first two-fifths of the period. After this there is a regular and steady decline to the end of the period.

(*ix*) There is no relationship between the composition of the milk given by a buffalo and the period of the lactation except when the animal is rapidly becoming dry.

PART III.—FOREST CHEMISTRY.

BY

PURAN SINGH, F.C.S.,

Forest Chemist.

The following is a brief account of the more important work carried out by the Chemical Department of the Forest Research Institute during the year under report:—

Conifer Resins.—*Pinus longifolia* resin has been the subject of a detailed investigation both at Dehra Dun and at the Imperial Institute, London, and the results obtained are embodied in the form of a report which is now in press. The turpentine obtained from *Pinus Merkusii* having been already pronounced by Professor Armstrong to be similar to that derived from *Pinus Khasya*, the latter alone has been examined at the Forest Research Institute. *Pinus Gerardiana* occurs at such altitudes that its exploitation for the distillation of turpentine oil would not be commercially possible, hence no effort was made to obtain samples of its resin. The only two species, therefore, left for consideration were *Pinus excelsa* and *Pinus Khasya*. The resins from these two species have been thoroughly examined and samples of turpentine oil have been distilled from them in the laboratory. From the chemical tests of these oils carried out by the Forest Chemist, it is clear that both of them are high grade oils similar in all their properties to the high grade American oil. Samples of both these oils have been sent to the Imperial Institute, London, for commercial valuation. The data for a complete report on the subject are ready but the subject is kept pending till the receipt of the Imperial Institute Report.

Myrabolams.—Nine specimens of myrabolams, half ripe, nearly ripe and perfectly ripe, received from the Forest Economist, were examined for their tannin value. It ranged between 44 per cent. to 53 per cent. from October to March in half ripe fruits and between 42 per cent. to 50 per cent. in nearly ripe fruits and between 48 per cent. to 52 per cent. in ripe fruits. From these results the writer in his Note on the best season for collecting myrabolams for tannin material, published in the "Indian Forester" of September 1911, concluded that the longer the fruit is allowed to remain on the tree, the higher is its tannin value, and he recommended that myrabolams should be collected when they are perfectly ripe. In order to support this conclusion, it was proposed to analyse a greater number of specimens from different localities. This

work could not be taken up this year, as no more samples of myrabolams were received. It is hoped that a good number of specimens will be collected for examination from November 1912 to March 1913 and the investigation will be continued next year.

Tan barks and woods.—This investigation was started in 1911 and will be continued to the end of the year 1913. The results obtained so far go to show that the percentage of tannin in air-dried barks does not suffer any appreciable decrease, while in the case of barks exposed to atmospheric changes, as is already well known, the tannin is rapidly oxidised.

Catechin.—An interesting observation has been made on the total loss of Catechin that the old wood of *Acacia Catechu* undergoes, probably by alternate oxidation and anhydration. In a specimen of *Acacia Catechu* wood 40 years old, it was found that the whole of its Catechin had changed into Catechu red. Another specimen obtained from the Siwaliks, which in its fresh condition in 1907 gave 10·9 per cent. of Catechin, 13·7 per cent. of alcoholic extract and 21·8 per cent. of aqueous extract, gave in 1911 only about 8 per cent. alcoholic extract and 8 per cent. of watery extract and Catechin *nil*. Most of its tannin had also oxidised into Catechu red. This wood was lying in the laboratory exposed to changing climatic conditions for four years, being roughly used for various purposes in the laboratory.

Canarium bengalense resin.—The resin of *C. bengalense*, received from the Forest Economist, was refined and then samples were prepared by mixing 8 per cent. and 16 per cent. of bee's-wax to lower its melting point with a view to make the resin serviceable as a shellac substitute in the manufacture of crape, etc. These samples were sent to the Imperial Institute, London, for commercial valuation. The Institute submitted these samples to a firm of crape manufacturers for technical trials with the result that the sample of the resin mixed with 8 per cent. of bee's-wax was pronounced to be most likely to be serviceable, as its clearing properties were superior to those of the refined resin and the one mixed with 16 per cent. of bee's-wax. It was impossible, however, to obtain as stiff a finish with this resin as with shellac. For a soft finish, however, there seemed to be a likely demand. The results of the trial indicated that this resin mixed with 8 per cent. of bee's-wax might find a restricted application in finishing crape. Further work to improve the quality of this resin as a shellac substitute was given up as the tendency of the lac consumers to seek substitutes had ceased, owing to the low price of lac.

Boswellia serrata gum-resin.—Attempts were made this year to refine the *Boswellia serrata* gum-resin and to prepare the different products from it. A gum resembling in its properties gum Tragacanth, a resin similar to *Canarium bengalense* resin and an essential oil which has already been reported by Professor Dunstan as consisting of l-pinene and other terpenes were experimentally prepared. It is hoped that the gum mentioned above might probably form a substitute of gum Tragacanth in calico printing, etc., and the resin may find some useful application in the varnish industry and as an adulterant of shellac, but all this has yet to be tested on a commercial scale. The oil seems to be a valuable one inasmuch as it may serve as a base for the preparation of some of the artificial perfumes, perhaps camphor, and it might be useful as a soap perfume. The investigation will be continued next year.

Podophyllum Emodi resin.—Three samples of *Podophyllum Emodi* were received from the Forest Economist for analysis with a view to ascertaining the best season for collecting the herb. These samples were collected in May, September and November 1910. From the results obtained, it was seen that the younger the rhizome, the greater is the percentage of resin that it contains. The sample collected in May gave about 14 per cent. of resin, which diminished in September to 8 per cent. and in November to 7 per cent. On the other hand, the percentage of Podophyllotoxin increases with age from 35·34 per cent. in May to 37·07 per cent. in September and to 49·77 per cent. in November. The older root though poorer in resin than the younger root is richer in Podophyllotoxin and consequently more active medicinally. The conclusion arrived at was that the rhizome should be collected in May about the time when the plant is in flower and not in the autumn as has been suggested.

Seventeen samples of Podophyllum roots have been examined at Dehra Dun from time to time during the last four years in order to determine the variation in the percentage of resin contained in the plant. It was found that excepting a sample of rhizome obtained from Kalatop, Chamba, which contained 19·5 of resin, the percentage of resin in the other sixteen samples varied from 8·60 to 16·82 in the rhizome and from 3·9 to 13·94 in the hair-roots. From the results obtained, which have been published in the form of a Forest Bulletin, it would be safe to assert that an average quality of the Indian plant will contain as a rule twice as much of the active principle as the American, and the variation in its physiological properties, as determined in England from time to time an samples sent from India, is accounted for

by the fact that the percentage of the resin in the root as well as the medicinal activity of the Indian plant differs not only with the season of its collection, but also with the locality where grown. In another paper on *Podophyllum Emodi,* contributed by the Forest Chemist to the "Indian Forester," it was suggested that *Podophyllum Emodi* of standard quality could be produced by artificial cultivation and by collecting the rhizome in one particular season.

Sandalwood oils.—Ten specimens of Sandalwood have been examined this year for their oil value. A specimen received from the Divisional Forest Officer, Belgaum, Bombay, consisting of wood taken from trees grown on very poor soil covered with sandstone boulders at an elevation of 2,500 feet gave 4·44 per cent. of oil by steam distillation. Four samples of Sandalwood were analysed for the District Forest Officer, North Coimbatore, Madras. Five specimens of Sandalwood were sent by Mr. S. M. Lushington, Conservator of Forests, Central Circle, Madras, taken from the trees grown at the Kodur plantations, East Cuddapah Division, at an elevation of 800 feet only. He suggested that the analysis of these roots should prove of great value as it is usually supposed that at a low elevation the tree does not produce wood of any real value. As the tree has been introduced at low elevations both in the Northern and Central Circles of Madras on a fairly extensive scale, it is important to decide whether there should be any further advance in this direction. The results of the examination of these five specimens show that they contain 4—6 per cent. of oil. These results indicate that the Sandalwood derived from the trees grown at low elevation are quite as rich in oil as the other highly prized ones.

As mentioned in the last year's Report of the Board of Scientific Advice, a preliminary Note on the oil value of Sandalwood from trees grown in rich as well as poor soils, received from Madras, was published last year, but as suggested by the Editor, "Chemist and Druggist," London, a greater number of samples of Sandalwood should be examined to confirm the conclusion arrived at in the said Note. The investigation proposed by Mr. Lushington in the same connection to determine the oil value of Sandalwood grown at low elevation is also an important one. The Forest Chemist, therefore, proposes to include the determination of the oil value of Indian Sandalwood in his next triennial programme in order to investigate more definitely the factors which determine this value by examining at least one hundred specimens taken from trees grown at different localities, different elevations and in different soils.

Nickel tannates.—While estimating tannin by means of nickel hydroxide, it was noticed that tannic acid combines chemically with

nickel hydroxide. In order to investigate the chemical composition of the salt formed by the interaction of these two substances, a preliminary investigation was made, which shows that tannic acid combines with nickel hydroxide in different proportions under different conditions of precipitation and formation of the salt. The best method to make these salts consists in precipitating nickel hydroxide dissolved in ammonia and ammonium salts by means of tannic acid solution. In this way a series of salts is formed containing less NiO when the solution of nickel hydroxide in ammonium salts is completely precipitated by an excess of tannic acid solution and more NiO when it is fractionally precipitated.

(1) The solution of nickel hydroxide in ammonium chloride was precipitated fractionally by means of Kahlbaum's "extra pure" tannic acid solution, and the nickel tannate thus formed was first washed by decantation and then in a funnel connected with a filter pump till the washings were free from chlorides. It was then dried in a desiccator in partial vacuum. The desiccator-dry salt was taken both for nickel determination and for the moisture determination at the same time. In this salt, NiO found = 28·5, calculated on the dry salt.

(2) The same as in No. (1), but the nickel hydroxide solution was completely precipitated by an excess of tannic acid solution. NiO found = 8·96 per cent. calculated on the dry salt.

(3) The solution of nickel hydroxide in ammonium acetate was fractionally precipitated by means of tannic acid solution. Further treatment of the salt as in No. (1). NiO found = 23·76 per cent.

(4) The same as in No. (3). The solution was completely precipitated by means of tannic acid solution. NiO = 8·61 per cent.

When freshly precipitated, these salts are amorphous and greyish white in appearance, and on exposure to air gradually oxidise to a darkish brown powder. The salts which are completely precipitated, are more stable than the fractionally precipitated ones and they change their colour but little and that only superficially. They are insoluble in water, alcohol in ether, but dissolve in alkalis, making a dark brown solution out of which they can be precipitated by means of alcohol. The action of caustic soda is somewhat drastic on the salt. Ammonia is the best alkali for the purpose of making salts by precipitation.

In presence of excess of ammonia, the addition of tannic acid does not precipitate nickel tannate from the solution of nickel hydroxide in ammonia. After the addition of tannic acid solution in excess to the ammoniacal solution of nickel hydroxide, the nickel tannate can be

precipitated by the addition of an excess of alcohol. The nickel tannate prepared by precipitation with alcohol from the ammoniacal solution of nickel hydroxide gave 9·95 per cent. of NiO, being the average of two estimations. The composition of this salt very closely agrees with the formula where two molecules of tannic acid enter into reaction with one molecule of nickel hydroxide as shown in the following reaction :—

$$(C_{14}H_{10}O_9)_2 + Ni\ (OH)_2 = (C_{14}H_8O_9)_2\ Ni + 2H_2O.$$

The theoretical percentage of NiO required according to this formula is 10·65. The difference between the value found and the theoretical is 0·7 per cent. But considering that even "Kahlbaum's extra pure" tannic acid cannot be taken to be quite pure, it is clear that the theoretical salt of the above composition is formed by adopting the above process.

This investigation had to be left over for want of time and the Forest Chemist hopes that he will be able to continue it next year.

Lemon grass oil.—At the request of Dewan Tek Chand, I.C.S., Deputy Commissioner, Gujranwala, Punjab, a sample of lemon grass oil grown in his garden at Dehra Dun was examined. It contained 74·1 per cent. of moisture and 0·52 per cent. of oil or 2 per cent. on the dry grass.

Saussurea Lappa oil.—A sample of the roots of *Saussurea Lappa* (Kuth) of Kashmir was sent to the Forest Chemist by Rai Bahadur Pundit Keshwanand, E.D.C., for the determination of its oil value. The roots gave 13·23 per cent. of moisture or loss at 100° C. and 2·78 per cent. of oil. Messrs. Gildmeister and Hoffman in their "Volatile Oils" give 0·8 to 1 per cent. of oil. This percentage seems to be very low, it may be that the specimens examined were rather old. It would be interesting to analyse more samples of this valuable root. Accordingly Rai Bahadur Keshwanand is trying to obtain more specimens and the Forest Chemist hopes to continue this work next year. This investigation has an economic importance as the oil obtained from these roots is used as an adulterant of the perfume of violets in Europe and it would be worth while to inquire into the methods of its artificial cultivation, the percentage of oil in samples drawn from different localities, and the commercial possibilities of the oil.

Bamboo paper pulp.—Mr. William Raitt, F.C.S., Cellulose Expert, attached to the Forest Research Institute, Dehra Dun, has issued an important report on his investigation on bamboo as material for paper-pulp. This is now available in the published form in the

Indian Forest Records, Vol. III, Part III. Mr. Raitt's report gives valuable information on the chemistry of bamboo paper-pulp and he has for the first time removed various erroneous ideas on the subject that had resulted from the conflicting nature of the results of a considerable number of trials and experiments by pulp and paper-makers carried out in a somewhat unsystematic manner.

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ASTRONOMY.

BY

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Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic

light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disc in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Rowland with $3\frac{1}{4}$-inch ruling is usually employed.

(*d*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during employment of the spectroheliograph and associated instruments.

(*e*) An 8-inch visual achromatic lens from the Maharajah Takhtasinji Observatory, Poona, temporarily mounted in the

spectroheliograph room on a pier near the Foucault siderostat. It is used for forming a solar image on the spectrograph slit specially for sunspot work.

(*f*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a $3\frac{1}{3}$-inch concave grating of 10-foot focus mounted on Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating, and a collimating lens may be employed with either grating to cure astigmatism.

(*g*) An equatorial refractor, with an Evershed spectroscope attached, used for the spectroscopic study of sunspots and prominences by visual methods.

(*h*) A 6-inch equatorial refractor with a photo-visual object glass (this lens is also from the Maharajah Takhtasinji Observatory, Poona). A large camera has been attached and the whole instrument adapted for taking direct photographs of the sun. It will supersede the Dallmeyer photoheliograph previously employed for this purpose.

Routine work.—In addition to the daily records obtained by the two spectroheliographs and the photoheliograph, the routine work includes visual examination of sunspots and faculæ, observations of intensified or weakened lines in sunspot spectra, and of bright lines or displaced lines in spots and prominences. The position angles and forms of the prominences are also recorded. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the Observatory are issued; of the former 25 have appeared while of the latter the first has been published.

The solar constant.—No progress has been made in the method of estimating changes in the solar radiation by photographic comparisons between moonlight and first type stars on account of the difficulty in obtaining suitable apparatus for measuring the plates. It is hoped that satisfactory results may be obtained with a Hartmann photographic photometer which has been recently acquired by the Director.

Spectroscopic investigations.—Researches connected with the radial movements of the gases over sunspots discovered here in the year 1909 have been continued, but owing to the very small number of spots available for study during the year very little progress has been possible.

A considerable number of prominence spectrum plates have been obtained and measured for determining the velocities in the line of sight of eastern and western prominences due to the solar rotation. The results so far obtained are of great interest in that they indicate a much higher angular speed of rotation than the value derived from sunspot observations. The hydrogen of the chromosphere is known to be rotating faster than the general body of the sun from the spectrographic researches of Adams, and the prominences arising from the chromosphere and extending outwards into space appear to be forced round at a yet faster angular speed than the chromosphere. Individual prominences show large variations of velocity however and the results referred to are the mean velocities of about 60 prominences. The research will be continued whenever favourable opportunities occur with a view to verifying this preliminary result.

The completion of the electric installation early in the year 1912 has greatly enlarged the general scope of the spectroscopic work and terrestrial comparison spectra of the electric arc or spark can now be photographed side by side with the solar spectrum, the lines of the iron spectrum forming very convenient standards of reference for determining absolute velocities in the sun. As a test of the accuracy of the measurements of motion in the line of sight, as well as of the correctness of the adjustments of the spectrograph, comparison spectra of the sun and the electric arc were obtained with the sun at widely differing hour angles. The first plate was exposed at about 6 P.M. on March 27 and the second at 9 A.M. on March 28. In each plate there is shown a shift of the solar lines towards the red compared with the arc lines. This shift is made up of three components: (1) a shift due to a recession of the earth from the sun amounting at this date to 0·486 km. per second; (2) a shift due to the component of the earth's rotation movement in the direction of the sun, which is a motion of approach in the morning and recession in the afternoon; and (3) a shift of most of the solar lines towards the red and varying from line to line, which is supposed to be due to pressure in the sun's reversing layer.

The shifts due to (1) and (3) are constant for the two photographs, so that the difference of shift shown by the morning and evening plates should give (2). Measures of only 12 lines in the two plates gave a mean result from which is derived the value 0·52 km. per second for the earth's equatorial rotation velocity, or omitting four rather discordant lines 0·46 km. per second. The true value is 0·464 km. per second, a very satisfactory accordance considering the minuteness of the line displacements, which are of the order of 0·01 mm. on these plates.

With regard to the shift of the solar lines supposed to be due to pressure an excellent set of plates of the spectrum of the iron arc in air and the centre of the sun's disc has already been obtained. These will be measured for estimating the amount of the shift in different iron lines. A further set of photographs will be obtained in which the centre of the sun's disc is compared with the arc in vacuo. The measurement of these plates after correcting for the components (1) and (2) will give the values of (3), and these will be compared with known shifts due to pressure and with the relative shifts which the solar lines show when the centre of the disc is compared with the limb.

METEOROLOGY.

BY

J. H. FIELD, M.A., B.Sc.

Experimental work.—Owing to the absence on medical leave of the Director-General throughout the year and to the great shortness of scientific staff practically no new experimental work was possible during the year. A short series of pilot balloons was sent up in the early morning at Simla during a part of the monsoon, and their results have been worked out for publication with previous ones.

Publications.—These were of a routine nature only; no memoirs were published for the reasons which rendered impossible any progress under paragraph 1.

TERRESTRIAL MAGNETISM.

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Magnetic observatories.—*Bombay* (*Alibag*).—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city: it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern, a set of sight-reading instruments of Eschenhagen pattern, a Schulze earth-inductor, and ordinary magnetometers and dip-circles. A careful study by means of daily absolute measurements of all elements has shown that while the base line values of the self-registering instruments for declination and horizontal force were constant or varied uniformly within the limits of error, the base line values of the vertical force instrument varied irregularly from day to day, and the mean value of vertical force for a month as derived from weekly measurements, duly corrected from the magnetograph traces, might differ by as much as ·00010 C. G. S. from the mean as derived from daily observations. The examination of the matter is still in hand.

Dehra Dun, Kodaikánal, Barrackpore and Toungoo.—These observatories were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained through the year except for three weeks at Dehra Dun in May 1912; the records were then lost owing to dismantling of the instruments in order to permit of the carrying out of the repairs to which reference was made in last year's report.

The mean values of the magnetic elements for 1911 at the observatories are as follows:—

Observatory.	North Lat. and East Long.	Declination.	Horizontal force.	Vertical force.	Dip.
Alibag	18° 38′ 72° 52′	0° 54′ 43″ E.	C. G. S. ·36856	C. G. S. ·16250	23° 47′·1
Dehra Dun	30° 19′ 19″ 78° 3′ 19″	2° 29′·2 E.	·33238	·32136	44° 2′·0
Barrackpore	22° 46′ 29″ 88° 21′ 39″	0° 49′·9 E.	·37337	·22220	30° 45′·5
Kodaikánal	10° 13′ 50″ 77° 27′ 46″	1° 0′·2 W.	·37515	·01536	3° 52′·0
Toungoo	18° 55′ 45″ 97° 27′ 3″	0° 19′·3 E.	·38853	·16582	23° 3′·0

Magnetic Survey.—The general scheme was to execute a preliminary survey of the whole country and a detailed survey of those areas where, owing to local irregularities, further information was required. The preliminary survey was to consist of observations of declination, intensity and dip at about 1,100 stations, and measurements were to be made in successive years at about 22 ' repeat ' stations in order to effect the elimination of secular variation.

Field work was begun in November 1901, and up to the end of the field season 1909-10, 1,324 field stations had been occupied and 23 repeat stations established, in addition to 24 stations on the Seistan trade route where declination had been observed; observations had also been repeated at 142 old field stations, of which 15 have been re-occupied on two occasions. In the detailed survey 193 stations had been occupied.

During the field season 1910-11 three detachments were employed on field work, one under the officer in charge (Captain R. H. Thomas, R.E.), and two under provincial officers; a fourth detachment was employed on office duties at head-quarters.

Two detachments were employed on detail survey in Central India and Hyderabad State, where the Deccan trap area exhibits considerable abnormalities. These detachments also observed at repeat stations and permanently marked field stations in the vicinity of their areas. The officer in charge inspected the four survey base stations, re-adjusting the instruments where required. Comparative observations were made at each base station and at Alibag to determine the differences from the survey standard. Observations were also made at repeat stations and permanently marked old field stations. During the season full sets of magnetic observations were made at 78 detail stations, while 56 old field stations and 18 repeat stations were re-occupied.

The detachment at head-quarters was utilized in initiating the reduction of the declination data of the survey. A simpler empirical formula for the correction for diurnal variation has been devised by Mr. de Graaf Hunter, M.A.: the correction is based on the results of one, two, three or four base stations according to the numbers available at the date of any given field observations.

During the recess the reduction of the base station results for 1911 were completed and those for 1912 taken in hand. The computation of the field work carried out in the field season will shortly be completed.

The investigation of the instrumental differences in H. F., to which reference was made in last year's report, was continued.

The ' chronograph ' comparisons of 1911-12 have but served to confirm the view expressed in last year's report, *viz.*, that the observed discrepancies are to be attributed in the main to personal error in the vibration experiment, and the investigation has therefore practically resolved itself into the determination of the probable personal errors both of the field instruments and the survey base station instruments for the period 1903-09 during which the chronograph was not used.

This investigation will, it is hoped, be shortly completed, when the reduction of the H. F. observations can be put in hand.

Programme for 1912-13.—During the next field season, three field detachments will be available. Two will be employed on continuing the detail survey while the third under the officer in charge will visit the base stations and as many repeat stations as possible.

A fourth detachment will continue the reduction of the declination data, remaining at head-quarters.

GEOLOGY.

BY

H. H. HAYDEN, C.I.E., F.G.S., B.A., B.A.I. (T.C.D.), F.G.S., F.A.S.B.,

Director, Geological Survey of India.

CONTENTS.

MINERALOGY AND PETROLOGY.

1. Mr. Tipper continued his examination of the monazite-bearing sands of Travancore, and, in addition, has been able to detect the presence of this mineral in small quantities in very widely separated localities. It has been proved to occur in small quantities in the sands near Tinnevelly and also in the cemented dunes of that district, in the Vizianagram district, in concentrates from the Sabarmati river at Golwara in Idar State, and recently in tin concentrates from Southern Burma. Thanks to the kindness of Mr. H. P. Herbert, Manager, Morgan Crucible Company's Mines in Travancore, and Mr. E. Masillamani, State Geologist, specimens of the monazite-bearing pegmatites of that State have been carefully examined. The monazite is undoubtedly a primary accessory mineral, but, like many other accessory minerals, it

does not follow any particular order in crystallization. Some of these pegmatites are very rich in monazite. In spite of this, the conclusion to be drawn from a study of the sands is that the bulk of the mineral is derived, not from the pegmatites, but from the denudation of the charnockites and granulites in which the monazite probably occurs in small quantities.

2. During the course of his survey of Idar State, Mr. Middlemiss met with a rock of unusual type and one of considerable interest. It occurs as a band at the junction of the Idar biotite granite with the Kawa dyke of olivine-dolerite (gabbro) at one mile north-west of Kawa. Microscopically it is a coarse, dark and light rock, with large poikilitic patches of biotite. It is composed of a fairly large amount of orthoclase, occasionally porphyritic as in the Idar granite, abundant lath-shaped plagioclase (albite-oligoclase) and quartz, a considerable amount of pyroxene in rather small idiomorphic and hypidiomorphic grains, often gathered together into clusters and showing here and there change to uralitic hornblende, a large amount of biotite in great ophitic plates and, as accessories, iron ores and rather much apatite. Mr. Middlemiss regards this rock as a composite or "hybrid" one, due to chemical reactions between the two rocks now found on either side of it, *viz.*, the Idar granite and the younger intrusive Kawa dyke of olivine-dolerite. He concludes that owing to the basifying of the granite consequent on this intrusion, the quartz and orthoclase of the former have remained unaltered, but all the usually dominant microcline has disappeared, its place being taken by abundant plagioclase (albite-oligoclase); at the same time both the biotite and apatite of the granite have been largely reinforced. Or, regarding the reaction from the point of view of the basic rock, the more basic plagioclase (labradorite) has disappeared, as also has the olivine, whilst the pyroxene has persisted in more or less patchy groups. Except on the supposition of a commingling of material and chemical re-arrangement having taken place, it is difficult to classify a rock of such abnormal mineral constitution among the ordinary igneous rocks, and Mr. Middlemiss considers that all the conditions of its occurrence point to its being a hybrid.

3. During a course of study leave spent at Cambridge, Mr. Pascoe made a detailed examination of the lavas from Mount Popa in Upper Burma, and was able to confirm the conclusions of previous observers that these consist exclusively of andesites. He recognises two types, one a hornblende-andesite in which the hornblende phenocrysts show strong absorption borders and much alteration to magnetite, and the other a porphyritic augite-andesite with small rounded grains of olivine.

PALÆONTOLOGY.

4. **Lamellibranchs and gastropods from the Spiti shales.**—Amongst the collections from the Spiti shales sent to the late Dr. Victor Uhlig for description, there were a number of lamellibranchs and a few gastropods; these were handed over by Dr. Uhlig to Dr. Karl Holdhaus, whose description of the material has now been received and will shortly be published in the *Palæontologia Indica*. Dr. Holdhaus states that his examination of the bivalves tends generally to confirm the conclusions already arrived at by Dr. Uhlig from his study of the ammonites. At the same time the fauna seems to represent a very special and individualised facies, since, with the exception of certain species of *Astarte*, Dr. Holdhaus has been unable amongst 37 species to find a single one that is truly identical with similar species from other regions; he has thus unfortunately been compelled to create a number of new species and one new genus. The gastropods are few in number, poorly preserved and of no particular importance.

5. **Himalayan Ordovician and Silurian fossils.**—A very important work on Himalayan palæontology has just been completed by Mr. Cowper Reed, namely, a description of the Ordovician and Silurian fossils of Spiti and Kumaon. The material described includes Salter's duplicates of Strachey's original collections, Stoliczka's collections from Spiti, Griesbach's from Kumaon, Krafft's and mine from Spiti and Bashahr and various small collections made by Messrs. Hughes, La Touche and others. Mr. Cowper Reed has been able to recognise definitely both Ordovician and Silurian faunas, of which the most remarkable feature is the striking American stamp of the Ordovician. Thirty-four species are closely related to American forms, but "while the affinities of so many species are remarkably close, yet scarcely any or perhaps even none are absolutely identical"; Mr. Reed attributes this to "a certain amount of modification having taken place in the course of their long migration from America." Equally remarkable is the absence from the Ordovician fauna of any European affinities, a fact which is the more striking in view of the very marked European character of the Ordovician of the Northern Shan States. The Silurian fauna on the other hand, although showing distinct American affinities in the corals, is on the whole rather European, although the strong European facies found in the Shan States is not developed.

6. **Triassic fossils from Kashmir.**—Dr. Diener has completed, for publication in the *Palæontologia Indica*, a description of the collections of Triassic fossils made by Mr. Middlemiss in Kashmir during the last few years. Amongst these Dr. Diener recognises representatives of

the Lower Trias, Muschelkalk, and carnic stage of the Upper Trias. The lowest horizon of the Lower Trias, which is found at Pastannah, corresponds fairly closely with the Otoceras zone of Spiti and Kumaon. The genus *Otoceras*, however, has not been found in it, but *Ophiceras* and *Xenodiscus* predominate. An interesting feature of this fauna is the close connection that has been proved between these two last-named genera, the intermediate forms being comprised among Mr. Middlemiss' specimens. The lamellibranchs, however, are more important than the cephalopods, and include large numbers of *Pseudomonots* (*Claraia*), of which four species are particularly interesting as representing isolated elements of Mediterranean origin, but all leading forms of the Werfen beds of the Alps. A younger Lower Triassic fauna containing *Flemingites* and *Meekoceras* is attributed to the Hedenstrœmia stage of Spiti and Kumaon. A fairly rich fauna was obtained from this horizon in the Guryul ravine, and a similar collection from Mandakpal. The marked resemblance between the Lower Trias of Kashmir and that of Spiti and Kumaon is in decided contrast to the absence of resemblance, indeed to the dissimilarity, of the Muschelkalk. Throughout those more easterly parts of the Himalaya, the physical characters of the Muschelkalk are practically invariable, and the steep cliff of the nodular limestone always forms a characteristic feature which cannot be mistaken. This, however, appears to be quite absent from Kashmir. So far as the fauna is concerned, Dr. Diener confirms Mr. Middlemiss' view as to the absence of Lower Muschelkalk forms from all the collections hitherto made, whilst every fossil that can be assigned to the Muschelkalk appears to belong to the Trinodosus zone of other parts of the Himalaya. The only upper Triassic fossils in Mr. Middlemiss' collections consist of lamellibranchs and brachiopods, which, although marked by certain Upper Muschelkalk affinities, are regarded by Dr. Diener as, on the whole, indicative of a carnic age.

7. **Fossil plants from Afghanistan.**—Professor Seward has completed a detailed critical study of the plants collected by Mr. Griesbach and by me in Afghanistan. Mr. Griesbach's collections, which come chiefly from Chahil and Shisha Walang to the north of the Kara Koh (Afghan-Turkistan), are regarded by Professor Seward as perhaps as old as lias or rhætic, whereas my collections, chiefly from the country to the south of the Kara Koh (Saighan and Kahmard), he regards as Middle Jurassic (Inferior Oolite). This rather tends to confirm the suggestion (*Memoirs, Geological Survey of India*, XXXIX, page 77) that the volcanic Doab series of Saighan is represented in Afghan-Turkistan by the estuarine and shallow-water

marine deposits which contain *Halobiæ* of Upper Triassic affinities. Professor Seward also confirms the view that the affinities of the Afghan Jurassic flora are with that of the provinces of Fergana and Syr Darya, that is to say, of Angaraland rather than of Gondwanaland.

8. **Fossil plants from the Assam coal-measures.**—By the kindness of Mr. G. E. Harris, Agent and General Manager of the Assam Railways and Trading Company, Professor Seward has also been enabled to examine certain specimens of the Tertiary flora associated with the coal-seams of Margherita in Upper Assam. Good specimens are rare as the shale rapidly disintegrates on exposure to the atmosphere. In the present instance, however, Mr. Harris had obtained a large fossiliferous block, which he immediately varnished, thus preserving it for some time from the effects of the atmosphere. The fossils consist chiefly of dicotyledonous leaves, which Professor Seward has described under the name *Phyllites kamarupensis*. They are unfortunately not sufficiently distinctive to warrant any statement as to geological age.

ECONOMIC ENQUIRIES.

Asbestos.

9. **Idar State.**—During the course of his survey of Idar State Mr. Middlemiss discovered in the hills to the south-east of Dev Mori (23° 39′ : 73° 28′) a deposit of asbestos, which appears to be of excellent quality. It occurs in large rod-like masses, which, when soaked in water and dried, come out as long silky masses of beautifully white fibre. The mineral is the amphibole variety and is long in staple, some fibres being as much as eight inches in length. The deposit is being opened up by the local authorities and, if it proves to be of any size, should be well worth exploiting.

Coal.

10. **Assam.**—During his investigation of the oil-fields of Assam, Mr. Pascoe took the opportunity of visiting the valley of the Namchik river to the north-east of Margherita. Here he discovered a fine seam of coal, some sixty feet thick. The results of his investigation have already been published in the *Records of the Geological Survey* (Vol. XLI, page 214).

11. **Punjab.**—The proposed borings for coal on the Dilwal plateau of the Salt Range were put down during the latter part of the year, at

Tothral and Arar. These villages lie well back from the southern scarp of the range and are separated from one another by a distance of about $2\frac{1}{2}$ miles. If, therefore, there was a coal-field of any considerable extent below the nummulitic limestone of the plateau, evidence of its presence should be found below Tothral and Arar. No coal, however, was found at Arar, and a seam only a few inches thick at Tothral; at the latter place, the boring was carried to a depth of over 112 feet below the coal into the Olive series, and the general sequence proved to be similar to that at Dandot. The Arar and Tothral sections are given below, and that obtained from the previous boring at Dandot is added for comparison:—

	Arar.	Tothral.	Dandot.
Surface soil, débris and nummulitic limestone . . .	99′ 3″	117′ 0″	127′ 0″
Variegated shales . . .	10′ 6″	10′ 6″	11′ 6″
Limestone with some calcareous sandstone	131′ 9″	156′ 0″	140′ 6″
Alum shale	27′ 6″	24′ 2″	30′ 0″
Coal-seam	...	1′ 4″	1′ 10″
	Pink marl.	Grey shale.	Dark grey shale.

The persistence in character and thickness of the variegated shales lying between the two bands of nummulitic limestone is very marked, as also is the uniformity of the lower limestone. The results of these borings lead to the inference that the coal-seam is thinner under the Dilwal plateau than in the neighbourhood of Dandot, that is to say, that it thins out and disappears towards the north. The data are of course insufficient to admit of any definite statement to that effect, but they give us no encouragement to expect that the seam under the Dilwal plateau will ever be appreciably thicker than that along the scarp, whilst the results of these investigations hold out no inducement towards further borings on the other plateaux of the Salt Range.

Copper.

12. With a view to the preparation of a memoir on the copper deposits of India, Dr. L. L. Fermor was deputed to Sikkim to examine the ore-bodies of that State. The most important are those of Bhotang and Dikchu. Both deposits occur interbedded with the associated rocks,

being of the nature of interbedded replacement deposits; but whereas the Bhotang deposit is in a comparatively unmetamorphosed form of the Daling series, the Dikchu deposit occurs in the belt of highly crystalline mica-schists with associated gneisses, forming a boundary zone between the Daling series and the Sikkim gneiss. In both cases, the copper-ore is chalcopyrite, the chief associated sulphide being pyrrhotite. But, especially at Bhotang, galena and blende are also of somewhat common occurrence. Dr. Fermor finds the origin and mode of occurrence of these ores to be similar to those of the Singhbhum copper-lodes. In each area the lodes are interbedded in the Archæan rocks (Dharwars in Singhbhum and Dalings in Sikkim, the garnetiferous rock of Dikchu being probably a highly metamorphosed form of the Dalings); in each area the bodies of copper-ore have been formed by the metasomatic replacement of the associated rocks; and in each area the copper-bearing formations are close to large masses of granitic rocks, from which, one may conjecture, the copper-bearing solutions were derived. In Singhbhum there are numerous basic (epidioritic) dykes associated with both the granites and the Dharwar rocks (schists, quartzites, etc.), and, as an alternative to the derivation of the copper-bearing solutions from the granites, it is possible to suppose them to be closely connected with the basic dykes. The disposition of the Singhbhum copper deposits as an aureole in the Dharwars following the curvature of the Dharwar-granite boundary is, however, in favour of the former suggestion, which, as it happens, is also more suitable for explaining the derivation of the ores of Sikkim, where basic igneous intrusions are scarce.

13. Although the deposits of Sikkim are similar in mode of origin to those of Singhbhum, they differ from them remarkably in the diversity of their mineral contents which frequently include chalcopyrite, pyrite, pyrrhotite, blende and galena; in Singhbhum, on the other hand, the copper-lodes show, as a rule, only two sulphide minerals, chalcopyrite and pyrite—with traces of chalcocite at higher levels, probably representing a zone of secondary enrichment. In both Sikkim and Singhbhum, azurite, malachite, chrysocolla and chalcanthite are found in the oxidised zones of the lodes, but in Sikkim where the slopes are very steep and denudation under the influence of a moist climate and heavy rainfall is very rapid, the oxidised zones are much less predominant than in Singhbhum. In Sikkim the sulphide minerals may crop out at the surface in the fresh condition, but this practically never happens in Singhbhum, where one might doubt the existence of copper deposits, were it not for the presence of numerous ancient outcrop workings stained with green and blue oxidised copper minerals.

Engineering Questions

14. **Darjiling landslips.**—During the early part of October, a committee was convened to discuss the safety of the hill-sides surrounding Darjiling. Attention was chiefly centered on the Happy Valley slip, which was examined in detail; various suggestions were made with a view to preventing further landslips, but final measures were postponed pending a detailed geological survey on a large scale of the whole hill-side from the Court-house to the Jail. It is proposed to undertake this in the summer of 1912. Incidentally it should throw much-needed light on the nature and origin of the Darjiling gneiss, which in the Happy Valley appeared to be derived largely from the metamorphism of a pre-existing sedimentary series of slate and quartzite.

Galena.

15. **Simla Hill States.**—A visit was paid to Basantpur in Bhajji State, the site of the head-works of the Simla hydro-electric installation, where galena and stibnite were said to occur. Specimens said to represent deposits of each had been sent previously to the Geological Survey Laboratory, but had proved to be only galena, no ore of antimony occurring among them. The latter was said to have been found on the left bank of the Nauti Khad just above the flume, and two mule-loads of ore were said to have been taken away. In spite of careful search no trace of ore of any kind could be found at this locality; it would appear that the whole deposit had been removed.

A few lumps of galena and a considerable amount of slag are found in the alluvium of the stream running from Basantpur to join the Nauti Khad. The quantity noticed was, however, small and is probably derived from the small veinlets and clusters of galena to be seen here and there in the metamorphic limestone which occurs in large quantity in the neighbourhood. Similar occurrences of galena are common throughout the Simla Hill States and are not as a rule of any economic importance.

Gold.

16. **Mong Long State.**—On his return from leave, Mr. Coggin Brown was deputed to examine, on behalf of the Sawbwa, the gravels of the Möng Lông Sub-State in Hsipaw, where gold was said to occur in payable amounts. Mr. Brown found that the gravels, although rich in places, occurred in too small quantity to hold out any hopes of successful dredging operations and recommended that the deposits be

left to the Shans to work. A detailed report on the subject has been published.

Petroleum.

17. The oil-fields party consisted, in addition to Mr. Cotter, of Mr. K. A. K. Hallowes and Sub-Assistant Sethu Rama Rau. During the early part of the year, Mr. Hallowes was posted to Yenangyaung, but, after the monsoon, resumed field-work in the Pakokku district, where he has been engaged on a survey of the volcanic area in the northern part of the district. Sub-Assistant Sethu Rama Rau was engaged in mapping the area included in sheets 113 and 157 (Burma Survey, $1'' = 1$ mile) covering parts of the districts of Minbu, Thayetmyo and Magwe. Three anticlines were noted in this area, *viz.*, (1) the Migyaunge-Kyundaw anticline, (2) the Tagaing-Sinmadaung and (3) the Mindegyi-Kyawdo. Of these the first is approximately symmetrical, and has shallow dips ranging from 10° to 25°, the Pegu beds being continuous with those of the Minbu oil-field. The conditions are regarded as favourable for the storage of oil. The Tagaing-Sinmadaung anticline is asymmetric on the north and symmetrical on the south, but the dips are very high, and the economic possibilities of the area are regarded as poor. The Mindegyi-Kyawdo anticline is a symmetrical one with shallow dips ranging from 10° to 25°. The Pegu beds here are the continuation of those exposed near Yenaman and Thabyemyaung, where seepages are numerous; the area is therefore regarded as decidedly promising.

Steatite.

18. **Idar State.**—Reference has already been made to the asbestos found by Mr. Middlemiss in Idar State. It occurs among, and is closely associated with, large quantities of steatite. The latter is found between Dev Mori and Kundol (23° 40′: 73° 28′) and also at Ghánta (23° 36′: 73° 26′). The steatite is of very fair quality and occurs in enormous quantity, Mr. Middlemiss having calculated that at the first locality alone there are over two million tons in sight and within easy reach. A note on the subject has been published in the *Records of the Geological Survey*, Vol. XLII, page 52.

Tin.

19. **Nurunga, Hazaribagh district.**—In July, Dr. Fermor visited the Nurunga tin locality, already noticed in *Records of the Geological Survey of India*, Vol. XXXIII, page 235 (1906). The deposit was found to be of a very unusual character, consisting of a thin

band, some 6 inches thick at most, of cassiterite-granulite, forming an interbedded layer in a considerable thickness of microcline granulite: in addition to the band mentioned above—which often contains a very high proportion of cassiterite, as much as 30 to 50 per cent.—cassiterite is also found in sparsely scattered granules in the microcline-granulites, especially close to the cassiterite-granulites. Samples of the country-rock have not yet been analysed, but it seems unlikely that the amount of included cassiterite is sufficient to render the whole mass of rock worth treating as an enormous deposit of low-grade tin-ore. The specimens collected have not yet been thoroughly studied, but the mode of occurrence of the tin suggests that the cassiterite-granulite is a basic segregation from the acid granulites with which it is associated.

See also under *Wolfram.*

Water.

20. At the request of the Local Government, it was arranged that a traverse should be made across the Irrawadi valley from the western foot of the hills of the Southern Shan States to the outer ranges of the Arakan Yoma, with a view to ascertaining the possibility of obtaining supplies of water under artesian conditions. The work was undertaken by Mr. P. N. Datta, who made a complete traverse along the latitude of Pyawbwe. On the whole, the result was not very encouraging, but Mr. Datta indicated various spots at which artesian water might be found.

Wolfram.

21. **Burma.**—At the request of the Local Government, Mr. Page was again posted to Tavoy and Mergui with a view to assisting the local officials with advice in matters relating to tin and wolfram-mining. Owing to the great rush for wolfram concessions in Tavoy and to the complete absence of reliable maps, he found that there was great difficulty and delay in connection with the issue of prospecting licenses. Matters, however, are being gradually reduced to order and it is hoped that before long all pending applications will have been dealt with.

GEOLOGICAL SURVEYS.

Assam.

22. **Naga Hills: Mr. E. H. Pascoe.**—Having been deputed to Assam for the field-season 1910-11, Mr. Pascoe was permitted to accompany a column that left Kohima early in January for a visit to Makwari on the Assam-Burma border. The greater part of the traverse,

which was some 85 miles in length, lay over a monotonous sequence of Disang shales and slates with little to relieve it save occasional lenticles of quartz. Among the Disang beds, between Dimapur and Kohima, was recognised the Naogaon sandstone of Mallet forming the peaks of Kadiuba and Siwenuchika. In the extreme east of the area, occurrences of serpentine were observed corresponding to the band mapped by Mr. R. D. Oldham in Manipur. A thick massive conglomerate was another interesting feature of this part of the traverse. The serpentine has been derived from gabbro and peridotite, pieces of which rocks are common in the streams.

23. **Abor Hills.**—The despatch of an expedition to the Abor country offered an opportunity for exploration of a tract of which the geological conditions were entirely unknown and it was therefore decided that a member of the Geological Survey should be attached to the force. Mr. Coggin Brown was selected for the purpose and joined at Kobo early in December. Mr. Brown has been able to add largely to our knowledge of this part of the Himalaya and he deserves great credit for the energy and perseverance with which he pursued his work in the face of the many difficulties inseparable from an expedition of the kind. It was anticipated that the general sequence of strata recognised at different times in the outer zone of the Eastern Himalaya would be more or less followed in the Abor hills, and this proved to be the case. From Kobo northwards the flat alluvium was found to stretch to the foot of the hills as far as Pasighat. In every direction it is covered with dense forest and the luxuriance of the vegetation entirely masks the ground. North of Pasighat the road soon commences to rise over pleistocene deposits lying on a core of Siwalik rocks, and at Janakmukh there is a raised terrace section of pleistocene gravels 150 feet in thickness, the top of which is 350 feet above the present level of the Dihong.

24. The Siwaliks were crossed on the line of march between Pasighat and Rammidumbang, forming the outer lower-lying foot-hills which flank the higher ground to the north; they were found to consist of great thicknesses of various kinds of sandstones, the softer micaceous varieties often containing nests of bright lignite, undoubtedly the remains of waterlogged drift-wood deposited during the formation of the rocks. Landslips are very common in this zone and from the high Abor "jhums" (clearings) the light-coloured Tertiary strata show up well against the dark green of the Sub-Himalayan rainy forest which covers the hills.

25. The Siwaliks dip into the hills and have the customary appearance of being overlain by the Himalayan Gondwanas, the next series met with. Unfortunately no actual contact of the two systems was seen, but there is no doubt that it is the same here as elsewhere. The commonest rock types in this series are white and greyish-white indurated sandstones and quartzites, reddish ferruginous shales, black carbonaceous shales, often with clay-ironstone septarian nodules, hardened, greyish-blue shales in which a schistose structure has been developed, and coal-seams. Owing to the intense crushing to which they have been subjected the seams have been squeezed into lenticular patches and the coal itself rendered powdery and friable. It is believed that these coals are of no economic value. Near Renging bands of decomposed volcanic rock begin to make their appearance, interbedded with the Gondwanas, and further north there is a great development of trap-like rocks which have given rise to the peculiar physical character of the narrow gorge-like course of the Dihong through the lower Abor hills. These rocks have been named the Abor Volcanic series, but at present, mainly owing to the want of continuous exposures, it is not possible to fix their exact age, though in the presence of palagonite tuffs they bear a striking resemblance to the Rajmahal traps. This series is followed higher up the valley by metamorphic rocks which in general appearance and position appear to correspond partly with the Daling series of Sikkim.

Bombay, Central India and Rajputana.

26. Messrs. Middlemiss, Jones, Heron and Daru were engaged in the survey of parts of Bombay, Central India and Rajputana, together with a few connected areas in the Punjab and United Provinces which border the part of Rajputana worked by Mr. Heron.

27. **Mr. Middlemiss: Idar State.**—Mr. Middlemiss began work in Idar State, and spent from January to April there investigating a portion of the country new to the Geological Survey, but lying immediately south of Hacket's and La Touche's surveyed areas in Rajputana and north of Kishen Singh's mapped areas in parts of Bombay. He completed a well-defined area of about 729 square miles, lying centrally within sheets 118 to 120 and 144 to 146 of the Bombay $1'' = 1$ mile survey. The banded and bedded formations represented are a folded (N.N.E.—S.S.W.) complex of Aravalli calc-gneisses and other schists, Delhi quartzites—coming apparently above and folded with the latter,—Ahmednagar sandstone series and recent deposits. The most common form of the first of these,

occurring in limited exposures among vast spreads of alluvium, is a thoroughly crystalline aggregate of much calcite with varying amounts of quartz, microcline, plagioclase, diopside and sphene, and occasionally with much biotite or with wollastonite, scapolite, garnet and zoisite. Among it ramify innumerable small granitic veins of aplite, graphic granite, and pegmatite, which seem to be as old as the folding of the rocks among which they appear. There are also later intruded, rugged and grotesque, large masses of Idar granite (biotite and hornblende granite) and of quartz-porphyry bursting irregularly through the region regardless of the older series. Long sinuous dykes of vein-quartz (ultra-acid differentiation products of the Idar granite?) and one or two examples of a basic dyke (olivine-gabbro or dolerite), together with a contact, composite or hybrid rock, between the latter and the Idar granite, were also identified and mapped.

Of these intrusive rocks, Mr. Middlemiss specifically identifies the Idar granite with the Siwana and Jalor granites, and the quartz-porphyry with the Malani rhyolites of Western Rajputana (see La Touche, *Mem. Geol. Survey of India*, Vol. XXXV, pt. 1, pages 25 and 90—91) and the olivine-gabbro and dolerite with a very similar one also in Western Rajputana, described by Sir T. Holland (*loc. cit.*, page 91). But there are further resemblances between the two areas in the nearly horizontal Ahmednagar Sandstone series, which appears as cappings on the hills or in the deeply-cut rivers under the alluvium, and which probably represents the Barmer sandstone of Western Rajputana as well as the Lathi group of Jaisalmir and the Umia of Kathiawar.

28. **Economic.**—No minerals of sufficient importance to notice here have as yet been found, but the sandstone quarries at Ahmednagar yield an excellant free-stone, whilst marble and granite can also be obtained in any quantity.

29. **Mr. Jones: Gwalior.**—Mr. Jones spent a full season, from November to the middle of May, in the Amjhera and Ujjain districts, continuing the revision of the geological maps of the area and the investigation of the mineral resources of the State. The area is contained on sheets nos. 212 to 215 and 242 to 247 of the Central India and Rajputana survey (1″=1 mile). Of this the Bag area to the south took him to the interesting localities already surveyed generally by Messrs. Blanford and Wynne (*Mem., Geol. Survey of India*, Vol. VI, pt. 3) and later again in more detail by Mr. Bose (*Mem., Geol. Survey of India*, Vol. XXI, pt. 1).

30. Although Mr. Jones was primarily concerned with the possibility of finding ores of manganese in the crystalline rocks, he has incidentally contributed a newly coloured map of most of the Bag area in even greater detail as regards delineation of boundaries than the already detailed work of his immediate predecessor Mr. Bose. A feature of special interest in his report of this area, where the sequence of beds comprising Nimar sandstone, Nodular limestone, Coralline limestone, Lameta and Deccan Trap lie almost horizontally above the steeply dipping Bijawars or still older gneissic and metamorphic series, is the beautiful set of photographs which he has taken in illustration of this and other physical features. His report may generally be considered as a further study in a number of detailed and well-illustrated sections taken at points of special interest of the area already liberally treated by Bose. A further addition to the fossils, of about cenomanian age, collected especially from the Nodular limestone and the Deola and Chirakhan marl has also been made by Mr. Jones. Among these Mr. Tipper has specifically recognised *Hemiaster similis*, *Placenticeras mintoi* Vredenburg, and *Namadoceras scindiæ* Vredenburg. As before, no fossils were obtained from what have been called Lameta beds at the base of the Deccan trap, so that the points in debate with regard to that formation remain as they were.

31. **Economic.**—No manganese nor anything of special economic importance was found. In the Bijawar rocks near Bag, however, Mr. Jones found promising slates, and he has suggested that pits be opened in them to determine their quality and suitability for roofing, writing slates, etc.

32. **Mr. Heron: Rajputana, Punjab and United Provinces.**—From the middle of November to the first week in May Mr. Heron spent a full season in continuation northwards, eastwards and south-eastwards of his work in Alwar of the last two seasons. The formations exposed constitute isolated hill groups, gradually dying out in the Indo-Gangetic alluvium to the west of the Jumna, during which process they spread out from Rajputana (whence the work of determination originated) into the neighbouring areas of Delhi and Gurgaon districts of the Punjab, and Agra and Muttra districts of the United Provinces of Agra and Oudh. This large area is included in Atlas of India sheets 49 and 50 (1″=4 miles), and standard sheets (1″=1 mile), Punjab Survey nos. 321 to 325, Central India and Rajputana Survey nos. 283, 284, 312, 313, 337 to 341, 360 to 362, and United Provinces Survey no. 23, all of which are now completely surveyed.

33. The rock systems include those of the Alwar State already described in previous reports by Mr. Heron, namely, Aravallis (schist

series of Hacket), above these the Alwar quartzite series, which in the Biana hills becomes split up into several groups, and above these the Ajabgarh (Mandan) series of slates, shales, etc. Besides these, in the area surveyed there are examples of Hacket's "Gwaliors" of Hindaun (thinly laminated cherts with jasper layers) and the Bhander and Rewa sandstone stages of the Upper Vindhyans, which are not found in Alwar.

34. Notwithstanding the large surface covered, practically only one sheet (Central India and Rajputana no. 341) presents any variety of geological feature. This is embodied in the hilly mass of Alwar quartzites north-west of Biana and the Upper Bhander scarp to the south. The rest of the sheets comprehend long tailing-out ridges or hill-masses of either the Alwar series and Ajabgarhs with a few pegmatite veins, or of the Rewa and Bhander stages in monotonous regularity, the greater part of the structure of the country and all geological boundaries being hopelessly buried under the all-pervading alluvium.

35. With reference to the Biana hills in sheet 341, it is to be noticed that Mr. Heron upholds Hacket's sub-divisions of the Alwar series into five groups (*Rec., Geol. Surv. India,* X, 87, and XIV, 298), with one unconformity and several conglomerates indicating breaks in the succession. Near the middle of the lowest group (the Nitahars) there are two bands of volcanic rocks, traps and tuffs, the former of which Mr. Heron has determined as a dolerite in which the plagioclase has been replaced by quartz and muscovite or kaolin, and the augite by chlorite.

The "Gwalior" cherts of Hacket, Mr. Heron thinks may belong to the schist series and not to the true Gwaliors.

36. **Economic.**—Impure graphite and a tradition of gold at Sohna, some old copper workings west of Nitahar and the kaolin of Kasampur have long been known and are mentioned in the *Manual of the Geology of India,* Vol. III. Nothing further of importance has been found by Mr. Heron in connection with them. He describes, however, an excellent band of slate at present being worked by the Kangra Valley Slate Company near Kund railway station. Building stone from the long-celebrated Upper Bhander sandstone quarries in Bharatpur State is of excellent quality.

37. **Mr. Daru: Banswara and Dungarpur.**—Mr. Daru spent only a very short field-season engaged in the above survey, namely, the months of March and April. During the first fortnight of this he was occupied in Banswara, the completion of the survey of which left him free to pass northwards and westwards into new ground

in Dungarpur, where he surveyed 250 square miles in the extreme north-east of that State (sheets 175 and 176 of the Central India and Rajputana Survey). Mr. Daru describes the area as being entirely of Aravalli rocks, with igneous intrusives and a few patches of recent alluvium, most of the country being a continuation north-west along the strike of the formations as found in Banswara.

38. The Aravallis are of the "argillaceous" type, generally biotite schist, occasionally with garnet and staurolite, sometimes too with a large proportion of magnetite. This passes locally into quartz-schist. There is also found hard shale, phyllite, graphitic shale, muscovite schist, hornblende schist and apatite schist. Boulder beds preponderate in one area east of the Sabla chain of hills. Limestone is comparatively rare, such outcrops as occur being extensions from the Banswara area. Two bands of ferruginous cherty quartzite are found, also in extension of the Loaira rock from Banswara.

39. The intrusives in these consist of aplite, graphic granite and muscovite pegmatite, occasionally with tourmaline; and there are also quartz-felspar rock and vein-quartz, the latter being in both large and small veins and regarded as extremely acid representatives of the pegmatites. Granite, gneissose granite, syenite and diorite are also found. In two or three bands there are also examples of "interbanded quartz-hornblende schistose intrusives."

Burma.

40. The work of the Burma party has already been referred to under *Petroleum* and *Water*. In addition to the systematic survey being carried out in the oil belt, a survey was begun by Mr. Datta of the country lying along the western foot of the Shan Hills from Kyaukse southwards. Work was begun only just before the end of the year and there is therefore but little to report. Mr. Datta finds that the country in the neighbourhood of Kyaukse consists of an altered sedimentary series, now consisting of argillite, quartzite, micaceous schist and marble, associated with biotite granite to which the metamorphism of the sedimentary rocks is probably to be attributed.

Central Provinces.

41. It was decided this year to form a new field party, in addition to those already at work in Burma and Central India, the new party being for the systematic survey of the Central Provinces on the scale of $1'' = 1$ mile. Previous work in this province has been carried out on a variety of scales, and much of the province is practically unsurveyed.

The party has been placed under the charge of Dr. Fermor, and, as constituted for the field-season of 1911-12 includes also Messrs. H. Walker and C. S. Fox, Assistant Superintendents, and M. R. Ry. Vinayak Rao, Sub-Assistant. Babu Bankim Bihari Gupta, recently promoted from the post of Museum Assistant to one of the newly sanctioned posts of Field Collector, was also sent with this party in order to collect a typical series of Chhindwara rocks. The first area selected for survey comprises, on the northern line, the districts of Betul and Chhindwara as far north as the Satpura coalfields and the districts of Seoni and Mandla as far north as the district boundaries, and, on the southern line, the districts of Nagpur, Bhandara and Balaghat as far south as the Bengal-Nagpur Railway line. This area has the advantage of being, as far as is known, a homogeneous geological entity including a large proportion of unmapped country and the whole of the Central Provinces manganese-ore deposits with the exception of those of Jubbulpore. Maps on the 1″ scale are available for the whole of this area with the exception of the Nagpur district, of which the largest maps available are on the scale of 1″=2 miles. The Surveyor-General has, however, kindly modified the programme of work of the Survey of India party now engaged in preparing new maps of the Central Provinces and Berar so as to issue the topographical sheets of this district within the next two or three years. Meanwhile, work was commenced during the current field-season (1911-12) on the northern line of districts. The Betul district has been assigned to Mr. Walker, whilst the remainder of the party accompanied Dr. Fermor to the Chhindwara district in order to become familiar with the rock formations, the study of which was commenced as long ago as 1903 (Fermor, *Records*, XXXIII, pages 159—218, 1906). Sub-Assistant Vinayak Rao has since been sent to Seoni to commence mapping in that district on the lines established at Chhindwara, whilst Messrs. Fermor and Fox propose to survey the Chhindwara district jointly, as it contains a large area of varied Archæan rocks and gives a section across the Satpura Hills from the 1,000-ft. Nagpur-Balaghat plain on the south, across the Chhindwara plateau (2,200-ft.) in the middle, to the Mahadeo Hills bounding the southern edge of the Narbada valley on the north and frequently rising to elevations of over 3,000 feet. It is expected that a detailed survey of this district will furnish the key to the structure both of the Satpura Hills, which traverse the northern line of districts, and of the Archæan plains comprising the larger portion of the southern districts.

42. **Deccan Trap.**—In the short portion of the current field-season falling within the year under review, the only work carried sufficiently

far for report here is the detailed mapping of some 70 square miles of Deccan Trap lying on the 2,200-ft. plateau round the villages of Linga and Lahgarua, to the south of Chhindwara town. Dr. Fermor began detailed work on this area with the object of determining, in the first place, whether it would be possible to break up the Deccan Trap formation into divisions sufficiently well-marked to be easily mapped, or whether it would be necessary, as seemed probable, to colour the whole of this formation with one tint. Incidentally he wished to study in some detail the inner relationship of the vast succession of lava-flows, especially as to origin. Mr. Harker has expressed the view in his *Tertiary Igneous Rocks of Skye*, that the columnar doleritic flows interbedded in the Tertiary basic lavas of that island are sills intruded between the flows of extrusive basalts. To ascertain whether or not any such explanation could be applied to the Deccan Trap, it was decided to map, flow by flow, a selected area in which the existence of dolerite had been ascertained. Dr. Fermor and Mr. Fox first mapped a portion of the area jointly, determining the existence of four distinct flows; they then separated, Mr. Fox carrying the boundaries to the northern and western edges of the selected area and Dr. Fermor to the southern and eastern. The results of their work are of considerable interest. Each flow—except the uppermost, the surface of which has been denuded away—shows a vesicular, more or less amygdular, surface; and between each pair of flows there is usually an 'intertrappean' layer. This sometimes takes the form of a silicified sedimentary stratum a few feet thick—in some cases of limestone, and still frequently containing abundant silicified fossils, *Physa*, *Paludina* and *Lymnæa* (?)—whilst in others the intertrappean layer consists of a green clay, the 'green earth' of Indian geologists, sometimes associated with brownish and cream-coloured clays. The origin of this green earth seems to vary; in some cases, it has undoubtedly been formed by the alteration of the underlying lava surface, but in other cases the origin is doubtful. Sometimes both green earths and sedimentary intertrappeans occur together, the green earth usually overlying the sedimentary rocks. Mr. Fox has collected for careful study a series of specimens of green earths and green jaspers, both from these intertrappean layers and from the lava flows themselves.

43. The flows are numbered serially 1 to 4 from below upwards, flow 1 being the true basal flow in this area, as it rests directly upon the Chhindwara granite. With the exception of flow 2, all have normally the texture of basalts, but any flow may be exceptionally more coarse-grained, *i.e.*, doleritic. Flow 2 is, however, usually a crystalline dolerite,

and if any flow were to prove intrusive, it would be this one. Several other doleritic flows were discovered later in the season on the edge of the ghats fringing the Kanhan valley, but nowhere was any evidence of intrusive relations detected. On page 259 of the *Manual of the Geology of India*, second edition, the existence of phenocrysts of olivine in the Deccan Trap is referred to, but it is probable that the phenocrysts of plagioclase, so abundant in the basalts, have been mistaken macroscopically for olivine, for none of the officers working on the Deccan Trap formation of recent years have been able to detect this mineral in thin sections under the microscope, although serpentinous patches are commonly seen, representing in some cases, perhaps, original olivine. It is interesting to record, therefore, that both Dr. Fermor and Mr. Fox independently discovered olivine in flow 2, in which it appears to be a normal constituent, although frequently altered completely to serpentine, and rarely quite fresh. The separate flows do not rest on each other with horizontal surfaces, and by the judicious use of the aneroid, frequent surprisingly high variations of a particular flow from one point to another have been detected. Marked dips of several degrees have been noticed in many places. As it was uncertain whether any or all of these dips were to be regarded as due to tectonic disturbances or were to be attributed to the flows adjusting themselves to the irregularities in the surface of the underlying Archæan peneplain, Mr. Fox returned to the area at the end of the field-season when nearly all the streams were dry and the crops cut, so that the outcrops could be easily followed; as the result of this he has obtained evidence supporting the former supposition, and has succeeded in tracing out the position of gentle synclines and anticlines striking north by west and south by east. The probable truth of the explanation of these dips as due to post-Deccan Trap tectonic disturbances is supported by several marked dips observed by Dr. Fermor on descending the edge of the Deccan Trap plateau by the Ramakona ghat. It is not unlikely, however, that when the observations obtained are carefully worked out, some of the irregularities will prove to be due to the adjustment of the flows to the underlying Archæan peneplain.

44. The result of this work has been to show the possibility of mapping the Deccan Trap in detail, although it has proved exceedingly difficult and slow work; but, unfortunately, it will not be possible to continue this detailed work owing to limitations of time, although it is evident from the discovery of the gentle folds in the Deccan Trap referred to above that further detailed work might yield valuable results from the tectonic point of view. Further, this work indicates that there is no practicable grouping of the flows in this area suitable for mapping.

45. **The Shikarpur "craterlets."**—Whilst carrying out the detailed survey of the Deccan Trap lavas referred to above, Dr. Fermor discovered a series of remarkable, more or less circular, depressions in the surface of flow 1 in the Kulbehra river opposite to the village of Shikarpur. There are in all some 20 of these depressions varying from 3 to 23 feet in internal diameter. Some of them are beautifully circular, and, where filled with water, look as if they had been drawn with a pair of compasses, whilst others are oval or somewhat irregular in shape. Almost invariably these depressions have a raised rim (1 to 3 feet high) separating them from the surrounding lava surface. Whilst the material composing these rims is a compact, comparatively non-vesicular lava, that composing the main surface of the flow is vesicular and amygdular, as also is the lava occupying the interior of these depressions, where seen. The exact nature of these depressions is difficult to understand, but Dr. Fermor is inclined to regard them as vents formed on the surface of flow 1 as outlets from that flow only, probably for steam and gases, and perhaps also in some cases to release lava from still molten pools within the body of the partially solidified flow. There is some evidence of lava piled up by the side of one of these depressions. It is proposed, therefore, to call them 'craterlets,' in the absence of any better name. Nothing in the least like them is known anywhere in the Deccan Trap formation, except the gigantic Lonar Lake crater in Berar, which must have been formed after the close of the Deccan Trap extravasations; whilst these Shikarpur craterlets must have been formed before the erruption of flow 2 in the Chhindwara district and have been exposed by subsequent denudation.

Punjab.

46. The survey of the Tertiary rocks of the outer Himalaya in Kangra and the Simla Hill States was continued by Dr. G. E. Pilgrim, who was accompanied by Sub-Assistant Vinayak Rao. Dr. Pilgrim's general conclusions were referred to in last year's report and need not be recapitulated here. A considerable area was mapped on a scale of $1'' = 1$ mile.

Sikkim.

47. During his visit to Sikkim, Dr. Fermor took the opportunity of travelling as far north as Lamteng in the Lachen valley, in order to obtain an idea of the nature of the crystalline rocks lying between that place and Gangtok, and especially to examine the crystalline limestones (*Mem., Geol. Survey of India*, XXXVI, page 18) for purposes of

comparison with those of the Chhindwara district, Central Provinces (*Records*, XXXIII, pages 195—206, 1906). Until larger-scale topographical maps of Sikkim are prepared, it will not be desirable to map the geology in greater detail than is shown on Mr. P. N. Bose's map in *Records, Geol. Survey of India*, XXIV, which may be accepted as roughly correct. This map shows a large shield-shaped area of Dalings with the point of the shield to the north; the eastern edge of the shield has a north-north-west trend, corresponding with a similar strike of the Dalings and a general east-north-east dip under the crystalline complex which extends from this boundary right up to the Teesta, Lachen and Lachung valleys. This crystalline complex comprises both igneous and sedimentary rocks, the former consisting chiefly of varieties of biotite-gneiss, and the latter principally of limestones, calciphyres, mica-quartz-schists and quartzites. A large-scale map would show these para-schists as long strips striking north-north-west parallel to the strike of the ortho-gneisses, and Dr. Fermor advances the tentative view that these strips, which are presumed to be of sedimentary origin, represent portions of the Daling series folded in with the ortho-gneisses and rendered at the same time thoroughly crystalline. The Dalings may well be the equivalents of the Dharwars of the Peninsula (*Mem., Geol. Survey of India*, XXXVI, page 66), and in this case we may regard the associated gneisses as the foliated forms of post-Dharwar granites intrusive with regard to the Dalings. In support of this view of the nature of these para-schists, it is interesting to notice that the slates of the Daling series become more crystalline—phyllitic—as the gneiss boundary is approached.

GEODESY.

BY

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PRINCIPAL TRIANGULATION.

Since the submission of the last report to the Board of Scientific Advice, principal triangulation has been carried on in Bengal and Kashmir.

Bengal.

Chota Nagpur Division. The Sambalpur Series.

For the purpose of establishing well-fixed points to serve as base stations for secondary triangulation in the tracts between the meridians of 82° and 86°, south of latitude 24°, a principal meridional series has been commenced, emanating from the side Bhursu-Hariharpur of the Calcutta Longitudinal Series at a mean longitude of 85°, and extending southwards with a view to junction with the East Coast Series in about longitude 84°.

The tentative scheme of triangulation framed before the observers took the field included the extension of the new series from the side Birpokar-Turer of the Calcutta Longitudinal Series, in longitude 84° 7′.

Examination of the country over which the triangulation would have to be carried, however, showed that it was impossible to lay out well-proportioned figures with unobstructed rays. Reconnaissances were made, both to the east and west, but until longitude 85° had been reached the same unfavourable conditions were found to exist. Plateau succeeded plateau, each thickly wooded, on which mutually intervisible stations at suitable distances apart were difficult to locate and where, without the construction of tower stations, grazing rays could not be avoided. The topographical conditions place this region among the most difficult, from the triangulator's point of view, that India has to offer.

The deflection by 1° of longitude of the new series from its ruling meridian of 84° was held to be less objectionable than the adoption of an expensive scheme of tower stations and accordingly the new series

broke off from the Calcutta Longitudinal Series in longitude 85° and, as soon as possible, was bent towards the west to regain the 84th meridian.

By the middle of April 1912, the series had reached latitude 22° and consisted of four quadrilaterals and one pentagon with a central station, the two southernmost figures lying astride the meridian of 84°. This triangulation, 112 miles in length, covers an area of 2,570 square miles.

The mean triangular error of 21 triangles is 0″·473, the observations being taken with a 12″ two-microscope theodolite.

An astronomical azimuth was observed at Bhursu H. S. of the Calcutta Longitudinal Series, latitude 23° 16′, longitude 84° 44′. The value of the difference (Astronomical – Geodetic Azimuth) being – 6″·07.

Kashmir.

The Kashmir Principal Series.

At the time of submission of last year's report this series had been carried as far as Gilgit, and Lieutenant Bell, R.E., and Mr. Wainright had commenced reconnaissances to the northwards, the former of the Sakiz Jarab Range and the latter of the Hunza Valley, with a view to framing a scheme of triangulation connecting the Kashmir Principal Series with Russian triangulation on the Pamirs.

As regards the feasibility of establishing stations on the Sakiz Jarab Range, Lieutenant Bell reported that the main chain of peaks was inaccessible and that the hills immediately to the south, only a little less difficult to negotiate, were useless for his purposes as the view from them to the south was obstructed by high inaccessible peaks. He then explored and found impracticable the valley from Darkot to Garmush, 20,564 feet, and later ascended a peak to the south of the Darkot-Askuman Pass. From this point he obtained a view of the summits of the Sakiz Jarab Range. He reports, "the whole range consists of nothing but extremely sharp and precipitous peaks, while south of it, between the Yasin and Karambar valleys, there are many high peaks." This country, just to the east of the Darkot Pass, was thus found to be impossible of triangulation, and an examination was made of the Karambar valley. It was found that triangulation could probably be carried as far as Harmot or Imit, but that northwards from this place the valley becomes very narrow between precipitous hills and the further progress

of a triangulating party was impossible. The normal difficulties were increased by the flooded condition of the river and further reconnaissance in this district was abandoned for the time being with a view to its resumption when the river subsided. In the meantime, however, a feasible route had been found up the Hunza Valley and the whole efforts of the detachment have since been devoted to carrying triangulation northwards along that line. The connection of the Russian triangulation by principal work in this locality has therefore been abandoned.

SECONDARY TRIANGULATION.

Bengal.

Chota Nagpur Division. The Ranchi Secondary Series.

One hundred miles of secondary triangulation were completed in the neighbourhood of Ranchi. The series emanates from the South Parasnath Series at about latitude 23°, on the meridian of 85°, and following this parallel closes on the new Sambalpur Principal Series in longitude 84°. The triangulation covers an area of 988 square miles and numbers 13 triangles with an average triangular error of 2″·17. An 8″ micrometer theodolite was used.

Central India.

Hyderabad. The Bhir Secondary Series.

This series connects the Khanpisura Series with the Great Arc, following the 19th parallel. It has a length of 176 miles and covers 2,764 square miles.

Twenty-six stations were visited, forming a chain of twenty-four simple triangles. The observations were made with an 8″ micrometer theodolite and show a mean triangular error of 0″·9.

Madras.

Districts of South Arcot and Salem. The Villupuram Secondary Series.

A secondary series was completed along the parallel of 12°, extending from the Great Arc in longitude 77° 50′ to the South-East Coast Series in longitude 79° 20′. Its length is 99 miles and the 18 triangles composing it cover 1,106 square miles. The observations were made with an 8″ micrometer theodolite and give an average triangular error of 1″·77.

District of Madura. The Madura Series.

This series, of which only the building of stations has so far been accomplished, will be observed as a secondary series. It lies along the parallel of 10° between the Great Arc and the South-East Coast Series.

Bombay.

Bombay City. Triangulation network.

To serve as an adjusting framework for a large scale survey of Bombay City, a network of triangulation is being gradually extended over the Island. It is based on a pentagonal figure, with sides some seven miles in length directly connected with the Bombay Longitudinal Series. The completed triangulation covers an area of 75 square miles.

Kashmir.

Russian connection. Hunza Valley.

Mr. Wainright followed the course of the Hunza and Kilik rivers from Gilgit to the Kilik Pass. He found that the carrying of operations up this valley to points from which a junction with the Russian triangulation could be effected, though difficult, was feasible.

He reported that the pathway, good as far as Hunza, became very difficult in places between that place and Misgar, sometimes hung precariously on the face of precipices, sometimes crossing glaciers much serrated and crevassed.

The Hunza Valley having been found to be practicable, Lieutenant Bell's detachment has been occupied this hot weather in carrying a series of triangles along it from the head of the Kashmir Principal Series, towards either the Kilik or the Mintaka Pass. The latest information received points to Lieutenant Bell with one provincial officer having been at work in the neighbourhood of Misgar during the early part of July, while other officers of his detachment were occupied lower down the valley between Gilgit and Hunza.

Since writing the above I have learned with deep regret of Lieutenant Bell's death beyond the Kilik Pass.

Teram Kangri.

At the time of submission of last year's report only preliminary values could be given of the position and height of Teram Kangri, the peak discovered by Dr. Longstaff in 1909.

These preliminary values were based on Mr. Collins' plane table work and an aneroid barometer. The triangulation, carried by him up to his stations of observation, has been now computed, giving the following results:—

Teram Kangri. Lat. 35° 34′ 37″. Long. 77° 07′ 31″. Height 24,489 ft.

ASTRONOMICAL LATITUDES.

During the season 1911-12, latitude observations were made at eleven stations; one being in the Siwalik hills south-east of Dehra Dun, and the remainder on two triangulation series extending northwards from the line Ranchi-Lohardaga.

The reason for the selection of this locality was to attempt to define the position of the hidden chain of high density, the existence of which has long been suspected.

The values of the deflections of the plumb-line are as follows, the stations shown in italics having been observed at previously.

Name of station.	Latitude.	Longitude.	Height.	Deflection of the plumb-line.
	° ′	° ′	Ft.	″
Mahwari	23 26	84 54	3,153	+4·32
Bulbul	23 38	84 26	3,352	+8·81
Chendwar	23 57	85 26	2,814	+3·07
Hurilaong	24 2	84 22	1,378	+10·75
Teona	24 35	84 10	740	+10·82
Mahar	24 44	85 10	1,606	+10·24
Behar	25 12	85 31	391	+13·22
Mednipur	25 5	84 22	335	+8·33
Nuaon	25 35	84 14	251	+7·70
Dubauli	25 40	85 20	189	+6·76
Jalalpur	26 4	84 23	232	+6·14
Pahladpur	26 4	85 27	175	+6·23

A positive sign denotes a southerly attraction of the plumb-line.

Neglecting for the present the value at Bihar, the deflections north of latitude 24° decrease regularly, and though it may seem somewhat surprising to find southerly deflections at Jalalpur and Pahladpur within 100 miles of the outer Himalaya to the north, with flat plains stretching to a greater distance southwards, such deflections have been found before in similar localities and form the main evidence of the existence of the hidden chain of high density to the south, and the trough of low density under, or near the foot of, the Himalaya.

The small deflections at Mahwari and Chendwar seem to show that these stations are near to, and probably south of, the crest of the hidden chain, the comparatively high value at Bulbul being explained by its position on the extreme north edge of high ground. Latitude observations on the new series of triangulation now being executed south of Mahwari towards Sambalpur should prove of great geodetic interest.

The deflection at Bihar is the largest southerly deflection as yet discovered in India (that at Teona being the second) and the position of the station on a low hill rising only some 200 feet above the Gangetic plain precludes the possibility of a large correction for local topography such as exists at Bulbul. It seems likely, therefore, that the range of hills 12 to 15 miles south are of very great density, though unfortunately it was not possible to visit them.

Pendulum observations were made over the same area as the latitudes, and the results, which are dealt with elsewhere, show that gravity is probably in excess south of latitude 25°.

The station in the Siwalik hills, Khajnaur, is situated on a spur running north from the main range and the deflection found is somewhat less than at the four stations visited the previous year. This result seems somewhat contradictory, as in the last report the deflections on the crest and northern edge of the Siwaliks were stated to be larger than on the southern slopes. The deflections given therein were, however, provisional and the correct values are as given below:—

Station.	Latitude.	Longitude.	Height.	Deflection of the plumb-line.
	° ′	° ′	Ft	″
Lachkua	30 4	78 2	2,674	−28·90
Bullawalla	30 7	77 59	2,432	−28·97
Hatni	30 13	77 52	3,096	−29·59
Shorpur	30 14	77 58	2,916	−29·13
Khajnaur	30 16	77 53	2,576	−26·93

Until local topography has been allowed for it is idle to discuss these results, but in view of the fact that the deflection at the east end of the Dehra Dun base, some four miles north of Shorpur, is $-30''{\cdot}37$, the statement that the mass of the Siwaliks is probably not very great and of low density is probably correct.

PENDULUM OPERATIONS.

During the season 1911-12 measurements of gravity were made at 12 stations in Bihar, Chota Nagpur and the extreme eastern portion of the United Provinces. The results are shown in the table.

The last seven stations are in the Gangetic plain and gravity is everywhere found to be in defect, the residuals $(g_o''-\gamma_o)$ increasing in the usual manner as the Himalayas are approached. At the first five stations gravity is more nearly normal, but, except at Daltonganj, has not been found to be in excess. A study of the deflections of the plumb-line observed in this area and referred to elsewhere in this report would, however, seem to show that the chain of high density has been crossed between Ranchi and Sasaram* and we should therefore have expected to find gravity considerably in excess at Japla, Daltonganj and Gaya.

The values of $(g_o''-\gamma_o)$ depend, of course, on the corrections for height and mass that we apply to the observed value of g. The correction for height is definite and unalterable and allows for the increased distance of the station from the centre of the earth. The correction for mass, however, depends entirely on the assumption of the existence or non-existence of isostasy. The corrections in the table are computed on Bouguer's hypothesis, that surface masses are not compensated by deficiencies of density. The corrections based on the theory of underground compensation have not as yet been computed for all the stations, but the following are the values of $g-\gamma$ that have been found at present:—

Station.	$g-\gamma$ dynes.
Ranchi	+0·054
Daltonganj	+0·050
Japla	+0·027
Gaya	+0·028
Sasaram	+0·033
Monghyr	0·000
Arrah	−0·003

* *Vide* deflections found at Mahwari, Teona and Mednipur under heading Astronomical Latitudes.

These values seem to fit in well with the theory of the hidden chain of high density, but discussion would be premature until the isostatic corrections for mass have been computed for more stations.

In the report for 1909-10 a table was published showing the values of $g-\gamma$ computed on Hayford's hypothesis, *i.e.*, that of underground compensation. These corrections were only computed up to a distance of 100 miles from the station, time not having been available for more than this; and to show that the values of $g-\gamma$ there exhibited will be sensibly altered when the correction is computed for the whole earth, it is only necessary to state that the correction beyond 100 miles from the stations already computed varies from 0·012 at Ranchi to 0·029 at Monghyr.

Summary of results, 1911-12.

Station.	Latitude.	Longitude.	Height above M. S. L.	Observed g.	Correction for height.	Correction for mass.	Correction for terrain.	g_o=c. corrected for height only.	g_o''=corrected for height, mass and terrain.	γ_o.	$g_o - \gamma_o$ dynes.	$g_o'' - \gamma_o$ dynes.
	° ′ ″	° ′	Ft.									
Ranchi . . .	23 23 5	85 19	2,167	978·691	+0·202	−0·076	0	978·893	978 817	978·818	+0·075	−0·001
Daltonganj . .	24 2 5	84 4	707	978·827	+0·066	−0·025	0	978·893	978·868	978·861	+0·032	+0·007
Japla . . .	24 31 58	84 0	474	978·856	+0·044	−0·017	0	978·900	978·883	978·895	+0·005	−0·012
Gaya . . .	24 47 42	85 0	361	978·884	+0·034	−0·013	0	978·918	978·905	978·913	+0·005	−0·008
Sasaram . . .	24 57 21	83 59	340	978·903	+0·032	−0·012	0	978·935	978·923	978·925	+0·010	−0·002
Moghalsarai . .	25 17 3	83 6	257	978·919	+0·024	−0·009	0	978·943	978·934	978·947	−0·004	−0·013
Monghyr . . .	25 22 53	86 28	154	978·909	+0·014	−0·005	0	978·923	978·918	978·954	−0·031	−0·036
Arrah . . .	25 34 10	84 39	188	978·918	+0·018	−0·007	0	978·936	978·929	978·967	−0·031	−0·038
Buxar . . .	25 34 42	83 59	207	978·933	+0·019	−0·007	0	978·952	978·945	978·968	−0·016	−0·023
Muzaffarpur . .	26 7 5	85 25	179	978·934	+0·017	−0·006	0	978·951	978·945	979·006	−0·055	−0·061
Majhauli Raj . .	26 17 46	83 58	219	978·928	+0·020	−0·008	0	978·948	978·940	979·019	−0·071	−0·079
Gorakhpur . .	26 44 58	83 23	257	978·936	+0·024	−0·009	0	978·960	978·951	979·052	−0·092	−0·101

TIDAL OPERATIONS.

During the year tidal registrations by automatic tide-gauges have been continued at the following ports, with satisfactory results:—

Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein, and Port Blair.

LEVELLING OPERATIONS.

During the year 1911-12 the following lines of precise levels were run:—

(*a*) *In the Punjab.*

Shahpur to Sargodha.
Sargodha to Lahore.
Sargodha to Multan.

(*b*) *In Assam.*

Dumpep to Sylhet.
Sylhet to Karimganj.
Karimganj to Silchar.
Karimganj to Comilla.

(*c*) *In Burma.*

Minbu to Salin.

Salin along both sides of the Salin Chaung to the canal works.

Prome *viâ* Henzada and Maubin to Rangoon.

The line Magwe to Prome had been included in the programme, but it was not found possible to complete it. This line would have completed the first circuit formed in Burma. It is now intended to complete it in 1912-13.

In addition to the above lines of precise levelling some 235 miles of single levelling were carried out in the neighbourhood of Delhi, both as an aid for the surveying of contours for a map of Delhi and for the fixing of heights for engineering purposes.

I.—BOTANICAL SURVEY.

BY

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Eastern India.—Since the publication of the last report two more fasciculi—comprising over 7,000 numbers—of the numerical list of non-herbaceous flowering plants cultivated in the Royal Botanic Garden, Calcutta, have appeared. This nominally completes the first volume of the catalogue, which contains over 13,400 numbers. These numbers indicate individual plants or groups only. The number of different species is much smaller. In the numerical list there are many blanks so far, of which palms constitute the large proportion. During the year, however, a fairly representative collection of specimens from the palms cultivated in the garden were sent to Dr. Beccari, the distinguished Italian botanist and authority on palms, and he has kindly identified them, so that it will be possible in the second volume to fill in many of the blanks. Considerable progress has been made in elaborating the materials for the second or systematic volume of the catalogue.

In the Eastern Himalaya collections were made on behalf of the Botanical Survey by Mr. B. J. Gould, I.C.S., Mr. W. R. Jacob of the Forest Department, Mr. R. S. Lister of Pashok Tea Estate, Mr. W. W. Smith, lately Curator of the Herbarium of the Royal Botanic Garden, Calcutta, and by Mr. G. H. Cave, Curator of the Lloyd Botanic Garden, Darjeeling. Mr. Gould's collections numbering about 400 sheets were made about Gyantse. Messrs. Jacob and Lister collected in Bhutan, the former contributing over 200 and the latter over 100 specimens of interest. Messrs. Smith and Cave's collections were made in Sikkim and the Darjeeling district, and supplemented by the collections made by the Lepcha collectors of the Lloyd Botanic Garden, Darjeeling, they totalled about 1,400 sheets. Mr. A. Meebold also presented the Calcutta Herbarium with a small collection from the outer hills of the Darjeeling district. J. F. Duthie has described the following new species of *Boraginaceæ* from the collections made in the Eastern Himalaya and the Tibetan tableland beyond by several officers during the Mission to Lhasa and by Calcutta Botanic Garden collectors:—*Paracaryum trinervium*,

Eritrichium densiflorum, Microula pustulata, M. Younghusbandii, Onosma longiflorum, O. Waltoni, O. Waddellii.

Mr. J. S. Gamble has cleared up the confusion hitherto existing as regards the differences between the different species of *Arundinaria* bamboos found on the hills of Sikkim, and has separated off as a new species—called *Arundinaria Maling*—a species that has hitherto been confounded with *A. racemosa*. Mr. Gamble has given a key to the 10 species of *Arundinaria* he recognises as occurring in Sikkim.

M. R. Hamet has described under the name of *Sedum Karpelesæ* a new species of *Crassulaceæ* collected by Major H. J. Walton, I.M.S., in the neighbourhood of Lhasa. Herr E. Koehne has described two new species of *Rosaceæ, Sorbus arachnoidea* and *S. Wenzigiana* and a new variety of *S. rufopilosa* from the Eastern Himalaya. From the same region Herr Herter has described a new species of Club moss as *Lycopodium sikkimense*, and Mr. H. N. Dixon a new moss, *Pogonatum papillosulum*. Messrs. Burkill and Finlow have described a new variety of the common jute plant *Corchorus capsularis* L. occurring in Eastern Bengal. In Assam Mr. I. H. Burkill while officiating during the hot weather of 1911 as Director of the Botanical Survey, toured in the Khasia Hills, accompanied by Mr. S. C. Banerji of the Botanical Survey Department. Their tour resulted in an accession to the Calcutta Herbarium of over 800 specimens. Towards the end of 1911, Mr. Burkill was deputed as botanist to accompany the Abor Expedition. Despite the unfavourable conditions, seasonal, climatic and otherwise, that greatly hampered botanical work, Mr. Burkill returned with over 2,000 specimens, which with his notes will serve to add very materially to our knowledge of the vegetation of that little known frontier region. Mr. Burkill has under preparation a detailed account of the botanical results of the expedition, which will appear in the Records.

Meanwhile the following extract from a general account of the Abor flora which was read by Mr. Burkill at the recent assembly of the British Association may serve to indicate the general characteristics of the vegetation.

"Forest is the natural clothing of the Abor hills, where it obliterates the clearings of man quickly; and where woody plants, following herbs, invade the less inviting spots (1) as epiphytes securing places in the tree-tops, (2) slowly spreading on to the rivers' sterile sandbanks, and (3) invading the river-beds between their June level and their January level. The lecturer used his time chiefly in studying the constitution of the different types of forest met with, and these three intrusions,

The Plains forest is in a way a northward extension of the vast forests of Malaya. Like all tropical rain-forests, it has a great variety of foliage. It has three layers—(1) the layer of the wind-dispersed, relatively small-leaved, giant trees; (2) the layer of the animal-dispersed, large-leaved lesser trees not growing beyond the still air; and (3) the layer of the ground vegetation wherein the plants are not large-leaved except in the alleyways of the forest. The second and third layers are separated by a light-diffusion space.

In their relation to creepers the trees of the forest differ in interesting ways: some thrive by outgrowing the creepers in annual spurts; some thrive by smothering them.

The Lower Hill forest is of two kinds. On the south slopes it is not unlike the Plains forest; but on the north slopes rules a most distinct and characteristic forest composed chiefly of a tree called by the Abors 'Shingkeng.' There is little variety in the foliage of a Shingkeng forest. Above the base of the hills oaks appear, and rule in places. On very steep slopes a giant bamboo rules. The Upper Hill forest has very uniform foliage, and is rather of two layers than three.

Grasses, as in the Sikkim forests, are very rare in the whole countryside; it is only where the very copious rain is drained away to an unusual extent that they can exist: thus, the very steep slopes harbour the giant bamboos; Abor clearings on hill-crests enable *Saccharum* to exist for a while; very well trodden paths in the immediate vicinity of villages allow two species to grow; sandbanks grow grasses; one invades the river-bed, clinging to rocks; and the gravel-beds at the foot of the hills after cultivation become covered with *Phragmites*.

Elsewhere grasses, even on clearings returning to jungle, do not exist. The clearings after the crop is removed are seized on by *Ageratum*, *Bidens*, *Blumea*, *Gnaphalium*, *Triumfetta*, *Viola*, etc. Then follow shrubs out of which a *Calophyllum* and a *Macaranga* gradually come to rule, the foliage getting larger as the height of the scrub increases, until finally it passes back to the true forest.

The river's clearings are sandbanks. Grass, first of all, takes possession of them; then slowly trees invade them, those which come first being the most deciduous species of the countryside.

The fall of the River Dehong in the hills is 50 to 60 feet. Of terrestrial plants, a moss ventures furthest into the exposed river-bed; not quite so far ventures a *Jungermannia;* a fern, an *Equisetum*, a *Polygonum*, and the curious Euphorbiaceous *Homonoia* descend to a

limit which has a longer period above the flood; another *Equisetum*, two other ferns, and *Rhabdia* of the Boraginaceæ descend half-way; the grass already mentioned, a *Lactuca*, a *Blumea* (Compositæ), *Viola Patrinii*, a *Ficus*, and some other plants occupy in increasing degree the upper part of the banks. The grass makes such a dense mat of roots as to resist the wash of the current and to hold a soil. The *Homonoia* is a tree with a trunk buried in the shingle.

Humid all the year round, it is only on the bluffs and south slopes of the Abor hills that trees bare after their leaf-fall for more than a month are found. Where bare trees stand, the epiphytes of the upper layers of the forest can be seen easily; they are more commonly in considerable aërial gardens than solitary, for the presence of one plant enables another to get a footing. As with the forest trees, the larger-leaved epiphytes are rarely in the topmost layers of the forest, but live a little below.

Mosses and film-ferns are abundant on the tree-trunks; neither store water, but both withstand desiccation. Two film-ferns were sent alive to Kew in a letter—a matter of a month in post-bags—without any protection against desiccation, and are now growing there.

Epiphytic figs are common in the forest, where the crown of one attains a greater span than other trees, and its roots find their way to the soil more than one hundred feet below.

The forest attains a height of 120 to 180 feet. Phanerogamic parasites are common in it, showy mistletoes living in the tree-tops, and leafless parasites being common on the ground, such as the coral-red *Balanophora dioica* and brown *Rhopalocnemis phalloides* (Balanophoraceæ) and dark blood-red *Sapria bengalensis* (Cytinaceæ), which live on the giant vines, where these, running through the tree-tops, make the light on the ground below too dim for foliage plants."

From Mr. Meebold's previous Manipur and Naga collections, M. C. deCandolle has described the following new species of *Piper*:—*P. phalangense*, *P. lainatakanum*, *P. kapruanum*, *P. aurorubrum*, *P. makruense*, *P. Meeboldii*, *P. nagaense*. From the same collections, a new species, *Raphidophora manipurensis*, has been described by Dr. Engler and Herr Krause, while from the same region but from Sir George Watt's collections Herr Krause has described *Sorbus Wattii* as a new species. Mr. W. W. Smith has described *Craibiodendron Mannii* as a new species from the Jaintia Hills.

In Burma Captain S. M. Toppin, R.G.A., made a botanically important journey in company with the Khampti Long Mission during

December 1911 and January and February 1912. The route was from the confluence of the Mali Hka and N'mai Hka rivers to form the Irrawaddy, northwards along the region west of the Mali Hka to Patau, thence north-eastwards to the Nam Tamai or upper waters of the N'mai Hka, the easterly of the two rivers that unite to form the Irrawaddy. The area covered lies roughly between 26° and 28° N. Lat. and 97° and 98° E. Long. Captain Toppin's collections are now being worked out. In addition to the collections much interesting information has been furnished by Captain Toppin in his notes. An account of the botanical results of both his journeys will be published as soon as opportunity permits, but a few of Captain Toppin's notes may be given here. The area west of the Mali Hka, between 26° and 27° N. Lat., consists of low ranges of hills running from west to east, covered with evergreen forest mostly composed of species of oaks and *Castanopsis*, with an undergrowth of prickly palms, bamboo thickets, plantains, and an abundance of *Strobilanthes* and *Impatiens*. Begonias also were common. Further north the hills are higher but the general aspect of the vegetation not markedly different. The species of oaks appeared to be different and a Rhododendron was found. There was practically a complete absence of Balsams and but few *Strobilanthes*. No coniferæ were seen. North of 27° 15′ N. Lat. and west of the Nam Kiu tributary of the Mali Hka is the grassy plain of Khampti Long. This plain is at an elevation of 1,100 to 1,200 feet and is completely covered with tall thatch grass, the trees being confined to edges of ravines that run from west to east, and to a few isolated knolls. Captain Toppin's collections on this journey were therefore from three distinct areas, (*a*) the part of the Kachin region that occupies the west side of the valley of the Mali Hka; (*b*) the Khunnong area around the headwater of the Mali Hka and N'mai Hka, being east of the Nam Kiu tributary of the Mali Hka and north of 17° 15′ N. Lat.; (*c*) the Khampti Long plain, north of 27° 15′ N. Lat., and west of the Nam Kiu tributary of the Mali Hka. Captain Toppin's explorations cover the area to the west of the region explored by Lieutenant Pottinger, R.A., in 1897, the explorations of the latter having been mostly confined to the eastern side of the N'mai Hka valley, which as is now known—although it was unknown at the time of Lieutenant Pottinger's expedition—does not come within the proper Kachin Hill area.

In Lower Burma Mr. A. Meebold explored part of the district of Mergui in the spring of 1911, and in the end of 1911 and beginning of 1912 made a tour in the districts of Thaton and Salween, travelling beyond

Papun in the latter district. From the three districts mentioned Mr. Meebold has contributed some 2,500 sheets to the Calcutta Herbarium. Smaller collections were contributed by Captain R. H. Phillimore, R.E., from the Southern Shan States, and by Mr. C. G. Rogers, Conservator of Forests, from Pegu. Amongst them and previous collections made in Assam and Burma quite a number of new species have been discovered, though all have not yet been published. Descriptions of the following have, however, appeared:—*Paradombeya multiflora*, *Elæocarpus Robertsoni*, *Lespedeza sessilifolia*, and *Beilschmiedia Robertsoni*, all from the Southern Shan States by Mr. Gamble; *Gentiana Hesseliana*, originally collected by Parish at Moulmein by Herr Hosseus; *Bulbophyllum congestum* from the Kachin (Maru?) hills by Mr. Rolfe; *Hibiscus Watsoni*, *Hedyotis glauca*, *Styrax Lacei*, *Staurogyne shanica*, *Didymocarpus Burkei*, *Craibiodendron Mannii* (all from Assam or Burma) by Mr. W. W. Smith; *Fimbristylis Lacei* (Burma) by Mr. Turrill. Mr. J. S. Gamble has continued his work on the Flora of the Malayan Peninsula, a region which comes within the area treated in the "Flora of British India," and during the year there has appeared an account of the families *Nyctaginaceæ*, *Amarantaceæ*, *Polygonaceæ*, *Aristolochiaceæ*, *Chloranthaceæ*, *Lauraceæ* and *Hernandiaceæ*, all being worked up by Mr. Gamble, except *Polygonaceæ*, the account of which was contributed by the writer of this report. M. Casimir deCandolle has published in the Records of the Botanical Survey diagnoses of the following new species of *Peperomia* and *Piper* from the Malayan Peninsula:—*Peperomia kotana*, *P. Maxwellana*, *P. Wrayi*; *Piper bipedale*, *P. collinum*, *P. connibaccum*, *P. curtipetiolum*, *P. Curtisii*, *P. dindingsianum*, *P. erecticaule*, *P. eucalyptolimbum*, *P. febrifugum*, *P. filipes*, *P. flavibaccum*, *P. flavimarginatum*, *P. flavispicum*, *P. globulistigmum*, *P. gymnocladum*, *P. gymnophyllum*, *P. kotanum*, *P. Kunstleri*, *P. larutanum*, *P. longamentum*, *P. longibracteum*, *P. longicaule*, *P. magnibaccum*, *P. malaccense*, *P. Maxwellanum*, *P. minutistigmum*, *P. mucronatum*, *P. muricatum* forma *peninsulare*, *P. pilistipes*, *P. nigrantherum*, *P. obovantherum*, *P. paucistigmum*, *P. pentandrum*, *P. polygynum*, *P. protractum*, *P. puberulirameum*, *P. ramipilum*, *P. varispicum*, *P. Ridleyi*, *P. rufibracteum*, *P. rufispicum*, *P. Scortechinii*, *P. selangorense*, *P. semangkoanum*, *P. subalbicans*, *P. subfragile*, *P. subrubrispicum*, *P. subsessililimbum*, *P. velutinervium*, *P. xanthocarpum*. Other species from this region described since last report include *Wikstræmia Ridleyi*, *Henslowia monticola*, *H. Ridleyi*, *H. Wrayi*, *Scleropyrum Ridleyi*, by Mr. Gamble; *Strychnos pseudo-tieute* by Mr. A. W. Hill; *Lecanorchis Ridleyana* by Herr R. Schlechter.

Southern India.—Mr. C. E. C. Fischer, Deputy Conservator of Forests, has been the main support of Botanical Survey work in the peninsula. He has contributed over 1,200 specimens collected in various parts of the Madras Presidency, such as the Pulney and Anamalai Hills and in Coimbatore district. Mr. Fischer's large and excellently preserved collections will prove of great value when the Flora of the Madras Presidency comes to be written. Dr. C. A. Barber, D.Sc., Government Botanist, has given as much of his time to systematic work as his other engrossing duties permitted. The following is quoted from his report as Government Botanist for 1911-12:—

"*Systematic Botany.*—A considerable amount of attention was devoted to this section during the year because of the decision on the part of the Government to have a flora of the Madras Presidency prepared, and numerous reports were forwarded on the subject. There was practically no special touring for the collections of plants, but substantial additions were made to the collections of peppers and *Loranthaceæ* by the Government Botanist while on other tours and a few local expeditions were made by fieldmen. Much progress was made in getting the large accumulation of plants, collected in previous years by the Government Botanist named, although this work was still hampered by lack of staff and the absence of suitable herbarium cases. Some 7,700 sheets were finally written on and added to the special collection of Madras plants. Eighty duplicate sheets were received from the Calcutta Herbarium. A small herbarium of 250 species of plants was given to the Presidency College for teaching purposes and about 50 sheets were distributed to other correspondents. The whole collection of *Dioscoreas* was sent to the Reporter on Economic Products and named and returned by him. The valuable collection of *Grewias* remained with the Kew authorities throughout the year. An important addition was made to the illustrations of the Madras flora in the form of 513 pen and pencil drawings of plants. On investigation these turned out to be the originals of the plates in Wight's, Beddome's and other authors' published works on the Madras flora. They were received in an extremely dilapidated condition, but every effort is being made to preserve them in a series of specially prepared atlases. About 200 plants were named by the Assistant for various correspondents. The collection of 1,143 sheets of Madras peppers was overhauled by the Government Botanist and numerous dissections and drawings made. The specimens were sorted, arranged and named where possible and notes were drawn up for the information of the writer of the flora. A summary note on this work was prepared and forwarded for filing at Kew. The seed collection

was overhauled and it was found necessary to reject a large number on the ground of insufficient naming. About 280 new species were, however, added, so that the number at the end of the year was 600."

The following new species from this area has been published during the year:—*Decaschistia rufa* (*Malvaceæ*) by Mr. W. G. Craib.

Western India.—Although there is not now so much scope for exploration on the western as on the eastern side of the Indian Empire, there is abundant opportunity for study of the vegetation from the standpoint of particular orders, genera or species as distinct from the study of the vegetation of any definite geographical area. Both aspects of study are comprehended in Mr. W. H. Talbot's Forest Flora of the Bombay Presidency and Sind, the second volume of which—comprising descriptions and distribution of the forest species of the families *Rhizophoreæ* to *Gramineæ*—has appeared during the year. In this volume 526 species belonging to 247 genera and 51 orders are described. The richest orders are *Euphorbiaceæ* with 66, *Rubiaceæ* with 48, *Urticaceæ* with 36, *Acanthaceæ* with 34, *Convolvulaceæ* with 28, and *Apocynaceæ* with 24 species. The flora of Aden has been made for some years the subject of thorough study by the Rev. Father E. Blatter, S.J., who has now made ready for publication an exhaustive account of the vegetation, comprising the history of the botanical exploration of the region, the physical aspects of Aden, a statistical account of the vegetation, its general aspects, adaptations, flowering season and climate, geographical relations, origin, dissemination, together with a synopsis of the families and descriptions of the species. Altogether 250 species are described, nearly thrice as many as were mentioned by Anderson in his "Florula Adenensis" published about half a century ago. Arrangements have been made for the Botanical Survey Department to publish during the coming year this valuable contribution to the botany of the Indian Empire.

Mr. G. A. Gammie has issued a further instalment of his description of the *Orchidaceæ* of the Bombay Presidency, comprising the species of the genus *Peristylus*.

Mr. R. K. Bhide, Assistant Economic Botanist, Bombay, has published description of the following new species of grasses found in the Bombay Presidency:—*Danthonia Gammiei*, *Andropogon Paranjpyeanum*, *Enteropogon badamicum*, *Tripogon Roxburghianum*. The following new species or varieties of *Piper* collected by Mr. Meebold in Western India have been described by M. Cas. deCandolle:—*Piper*

crenulatibracteum (North Kanara), *P. nigrum* L. var. nov. *mysorensis* (Mysore), *P. hymenophyllum*, form. nov. β (Mysore), *P. Talbotii* (Matheran). Mr. S. A. Watson, I.A., of of the 67th Punjabis has presented collections made by himself in the neighbourhood of Kach in Baluchistan. Mr. H. N. Dixon has described a new genus and species of moss *Bryosedgwickia Kirtikarri* from the Bombay side.

Northern India.—Colonel J. C. Bamber, I.M.S., has issued another part of his key to the flora of the Punjab, North-West Frontier and Kashmir. Lady Douie presented the Calcutta Herbarium with collections made by herself and by Mr. K. S. Imam-ud-din of the Forest Department in Kulu and Pangi respectively. Mr. J. H. A. Ivens has studied and recorded the general seasonal and altitudinal aspects of the flora of the vale of Kashmir. From the North-West Himalaya the following new species have been described:—*Leontopodium Evax*, *L. Jacotianum* by M. Beauverd; *Corydalis Onobrychis* (from Gilgit) by M. Fedde; *Sorbus Wenzigiana* (from Kumaon), and three new varieties of *S. cashmiriana* Hedbund by Herr Koehne; *Lespedeza dubia*, *L. indica*, *L. Meeboldii* by Herr Schindler; *Cynanthus cordifolius* by Mr. J. F. Duthie; *Lindbergia longinervis* (a new moss) by Mr. H. N. Dixon. The area of distribution of *Philonotis seriata* Mitten, a moss hitherto supposed to be confined to Europe and North America, has been extended by the recognition of its occurrence in the North-West Himalaya.

Additions to the known Flora.—During the year over a hundred hitherto undescribed species have been added to the number known to occur within the area covered by the "Flora of British India."

General systematic.—The Rev. Father Blatter, S.J., has compiled a very useful bibliography of the Botany of British India and Ceylon. The compilation is in two parts—(I) a general bibliography containing the titles of publications that treat of the Botany of India in general or of a greater part of India, (II) a regional bibliography that enumerates the books and papers dealing with the botany of smaller areas included wholly or partly in one of the botanical regions at present recognised in India. In all over 1,500 books and papers are cited. Parts V and VI of the same botanist's account of the palms of British India and Ceylon, indigenous and introduced, have appeared during the year, the species described belonging to the genera *Corypha*, *Nannorhops*, *Licuala*, *Livistona*, *Pritchardia*, *Washingtonia*, *Sabal*.

Considerable progress has been made towards the publication of the supplement to Doctor Beccari's account of the species of the genus *Calamus* of climbing palms. The same author has published a classification of the

palms of Indo-China. Mr. J. R. Drummond, I.C.S. (retd.), has published an elaborate and valuable critique of the Indian species of *Grewia* as understood, described or mentioned by Roxburgh. M. Gagnepain has revised the classification of the Asiatic species of *Buddleia*. Sir David Prain has critically revised the history, classification and distribution of the species of *Erythrococca* and *Micrococca*. His review is of importance to students of Indian botany from the occurrence of species of the latter genus in India. Herr Schottky has published an account of the oaks and allied genera of Eastern Asia and their geographical distribution. The Asiatic species of *Aponogeton, Paspalum* and *Panicum* have formed the subject of papers by M. Camus. The distribution and use of *Erythrina indica* Lamk. in Indo-China has been discussed by MM. Dubard and Eberhardt.

Mr. S. T. Dunn has published an account of *Primula bellidifolia* King and its allies, with a key to the group formed by that species and nine others. Papers of a more general systematic character, that in part directly or indirectly have a bearing on the botany of India, are mentioned in the list of publications at the end of this article.

Anatomical and physiological.—Professor Bower of Glasgow University has based one of his recent studies in the Phylogeny of the Filicales, *viz.*, "On *Lophosoria* and its relation to the *Cyatheodeæ* and other ferns," partly on material supplied by the Calcutta Botanic Garden. The same Garden supplied in part the material for an investigation by Mr. R. C. Davie into the structure and affinities of *Peranema* and *Diacalpe*, two Eastern Himalayan forms. Mr. I. H. Burkill has recorded a series of observations on the polarity of the bulbils of *Dioscorea bulbifera* L. as regards the sprouting of shoots. Mr. W. Burns has described a second year's growth of a plantain inflorescence.

Other investigations on anatomical or physiological lines with more or less application to Indian botany are mentioned in the list of papers appended.

A list of papers containing references to the Botany of India published mostly during 1911-12.

BAMBER, C. J. . . Plants of the Punjab, IX. (*Journ. Bomb. Nat. Hist. Soc., xxi, No. 1, 1911, p. 203-228.*)

BEAUVERD, G. . . Sur la distribution géographique des genres *Leontopodium* Cass. et *Cicerbita* Wallr. Emend. Beauv. (*Bull. Murithienne, xxxvi, 1911, pp. 44 and 77.*)

BEAUVERD, G. . . Nouvelles especes eurasiatiques du genre *Leontopodium*. (*Bull. Soc. Bot. Genève, 2nd Ser., i, p. 185-196, 1909.*)

BECCARI, O. . . Classification des Palmiers d'Indo-Chine. (*Bull. Mus. Nat. d'Hist. Nat., 1911, No. 3, p. 148-160.*)

BENOIST, R. . . Les genres *Lepidagathis* et *Lophostachys* sonts-ils distincts? (*Notulæ Systemat., ii, No. 5, 1911, p. 139-144.*)

,, . Contribution à la flore des Acanthacées asiatiques. (*Notulæ Systematicæ, ii, No. 8, 1912, p. 238-240.*)

BHIDE, R. K. . . New and revised species of *Gramineæ* from Bombay. (*Journ. Asiat. Soc. Beng., vii, No. 8, 1911, p. 513-520, with 4 plates.*)

BLATTER, E. . . A Bibliography of the Botany of British India and Ceylon. (*Journ. Bomb. Nat. Hist. Soc., xx, No. 5, 1911, p. lxxix-clxxxv.*)

,, The Palms of British India and Ceylon, Indigenous and Introduced, V and VI. (*Bomb. Nat. Hist. Soc. Journ., xxi, Nos. 1 and 2, 1911-1912, p. 66-86 and 343-391, with 15 plates.*)

BONAVENTURA, C. . Ricerche anatomiche súl fiore delle Orchidee. (*Nuovo Giorn. Bot. Ital., xix, 1912, No. 2, p. 167-293, with 4 plates.*)

BOWER, F. O. . . Studies in the Phylogeny of the *Filicales*. *Lophosoria* and its relation to the *Cyatheoideæ* and other ferns. (*Ann. Bot., xxvi, 1912, No. 102, p. 269-323, with 7 plates.*)

BURKILL, I. H., & FINLOW, R. S. *Corchorus capsularis* var. *oocarpus*, a new variety of the common jute plant. (*Journ. Asiat. Soc. Beng., vii, 1912, No. 8, p. 465-466.*)

BURKILL, I. H. . Polarity of the bulbils of *Dioscorea bulbifera* L. (*Journ. Asiat. Soc. Beng., vii, 1912, No. 8, p. 467-469.*)

,, The Forest of Kobo. (*Kew Bull., 1912, p. 159.*)

BURNS, W. . . Second year's growth of a plantain inflorescence. (*Journ. Bomb. Nat. Hist. Soc., xxi, 1912, No. 2, p. 706-707.*)

CAMUS, A. . . Note sur les éspeces asiatiques du genre *Aponogeton*. (*Notulæ Systematicæ, ii, 1912, No. 7, p. 202-204.*)

,, Note sur les *Paspalum* de l'Asie orientale. (*Not. System., ii, 1912, Nos. 7 and 8, p. 216-226.*)

,, Notes sur quelques *Panicum* de l'Asie orientale. (*Notulæ Systematicæ, ii, No. 8, 1912, p. 246-253.*)

CANDOLLE, DE, C. . *Piperaceæ Meeboldianæ* Herbarii Vratislaviensis. (*Repert. spec. nov. Reg. Veget., x, 1912, Nos. 266-270, p. 518-523.*)

,, Piperaceæ novæ a Peninsula Malayana. (*Rec. Bot. Surv. Ind., vi, 1912, p. 1.*)

COLOZZA, A. . . Contributo allo studio anatomico delle *Burmanniaceæ*. (*Bull. Soc. Bot. Ital., 1910, p. 106-115.*)

CRAIB, W. G. . *Decaschistia rufa*. (*Kew Bull. No. 1, 1912, p. 35.*)

DAUPHINÉ, A., & HAMET, R. Contribution à l'étude du genre *Kalanchoe*. (*Ann. Sc. Nat. 9, Ser. Bot., xiv, 4-6, p. 195-219.*)

DAVIE, R. C. . . The structure and affinities of *Peranema* and *Diacalpe*. (*Annals of Botany, xxvi, No. 92, April 1912, p. 245-268, with 2 plates.*)

DISMIER, G. . . Sur la presence du *Philonotis seriata* Mitten en Asie. (*Bull. Soc. Bot. de France, lix, 1912, p. 175-177.*)

DIXON, H. N. . . *Bryosedgwickia*, novum genus *Entodontacearum*, with further contributions to the Bryology of India. (*Journ. Bot., l, No. 593, 1912, p. 145-156, with 1 plate.*)

DOMMEL, H. C. . Ueber die Spaltöffungen der Gattung *Euphorbia*. (*Ber. deutsch. bot. Ges., xxviii, 3, 1910, p. 72-77, with 1 plate.*)

DRUMMOND, J. R. . The Grewias of Roxburgh. (*Journ. Bot., xlix, Nos. 587 and 588, 1911, p. 329-337 and p. 357-363.*)

DUBARD, M. . . Remarques sur la classification des Sidéroxylées. (*C. R. Acad. Sc. Paris, cvii, 1911, p. 390-393.*)

Dubard, M., & Eberhardt, Ph.	*L'Erythrina indica* Lamk. en Indo-Chine. (*Bull. Mus. Nat. Hist. Nat., 1910, No. 6, p. 333-337.*)
Dunn, S. T.	*Primula bellidifolia* King, and its allies. (*Notes from the Roy. Bot. Gard. Edinburgh, No. xxiii, 1911, p. 61-64, with 1 plate.*)
Duthie, J. F.	Diagnoses of new Indian species. (*Kew Bull. No. 1, 1912, p. 37-41.*)
Engler, A., & K. Krause.	*Raphidophora manipurensis.* (*Bot. Jahrbüch, xlv, 5, 1911, p. 659.*)
Esenbeck, E.	Ueber die Systematik der Gattung *Melampyrum.* (*Mitteil. bayr. bot. Ges. Erforsch. heim. flora, ii, 4, p. 239.*)
Fedde, F.	*Corydalis Onobrychis*, eine neue Art aus Kaschmir, aus der Verwandtschaft der *C. astragalina.* (*Repert. spec. nov. Reg. Veget., x, 1912, Nos. 266-270, p. 565.*)
Gage, A. T.	*Polygonaceæ*, in "Materials for a Flora of the Malayan Peninsula, No. 22." (*Journ. Asiat. Soc. Beng., lxxv, Pt. I, 1912, p. 18-23.*)
,,	Catalogue of non-herbaceous Phanerogams cultivated in the Royal Botanic Garden, Calcutta. Part I. Numerical List. 3rd and 4th Fasciculi. (*Rec. Bot. Surv. Ind., v, Nos. 2-4, p. 169-367.*)
Gagnepain, L. F.	Revision des Buddleia d'Asie. (*Notulæ Systematicæ, ii, 1912, Nos. 6-7, p. 182-194.*)
Gamble, J. S.	Materials for a flora of the Malayan Peninsula, No. 22. (*Journ. Asiat. Soc. Beng., lxxv, Pt. I, 1912, p. 1-204.*)
,,	The Arundinarias of the Hills of Sikkim. (*Kew Bull., 1912, No. 3, p. 135-140.*)
,,	Diagnoses of new species in "Decades Kewenses." (*Kew Bull., 1912, No. 4, p. 198-202.*)
Gammie, G. A.	Orchids of the Bombay Presidency, XII. (*Journ. Bomb. Nat. Hist. Soc., xxi, No. 1, 1911, p. 171-174, with 1 plate.*)
Gibbs, L. S.	On the development of the female strobilus in *Podocarpus.* (*Ann. Bot. xxvi, No. 92, 1912, p. 515-571, with 5 plates.*)

GOEZE, E. . Zur Geschichte der *Prunus* und *Pyrus* Arten. (*Oesterr. Gartenr., vi, 1911, No. 3, p. 87-90; No. 4, p. 137-142; No. 5, p. 180-186.*)

GUIGNON, J. . Le genre *Euonymus*. (*La Feuille des J. Natur., xli, 1911, p. 70-73.*)

HALLSTROM, K. H. . Zur entwicklungsgeschichte der Fruchtwand von *Ceratonia siliqua* L. und *Tamarindus indica* L. (*Ber. deutsch. Pharm. Ges., xx, 1910, p. 446-480.*)

HAMET, R. . Observations sur la germination des Crassulacées. (*Bull. Soc. Bot. France, lviii, 1911, Mem. 21, p. 13.*)

" *Sedum Karpelesæ*. (*Bull. Soc. Bot. de France, lviii, 1911, p. 615-617.*)

HERTER, W. . Beitrage zur Kenntnis der Gattung *Lycopodium*. (*Bot. Jahrb., xliii, 98, p. 1-56, 1909.*)

HILL, A. W. . *Strychnos Ignatii* and other East Indian and Philippine species of *Strychnos*. (*Kew Bull., 1911, No. 7, p. 281-302, with 2 plates.*)

HOOKER, J. D. . On some Western Peninsular Indian Balsamineæ collected by Mr. A. Meebold. (*Kew Bull. No. 9, 1911, p. 353-356.*)

" Icones Plantarum, X, Pt. III, Tab. 2951-2975. [Description and plates of new species of Impatiens.]

HOSSEUS, C. O. . Eine neue *Gentiana* (*G. Hesseliana* Hoss.) vom Pahombukgebirge (2300 m. ü. de M.) auf der Siamesisch-birmanischen Grenze. (*Repert. nov. spec. Reg. Veg., ix, 1911, Nos. 27-31, p. 465-466.*)

HUME, E. M. M. . The histology of the sieve tubes of *Pteridium aquilinum*, with some notes on *Marsilia quadrifolia* and *Lygodium dichotomum*. (*Ann. Bot., xxvi, 1912, p. 573-587, with 2 plates.*)

IVENS, J. H. A. . Notes on the flora of the Vale of Kashmir. (*Journ. Bomb. Nat. Hist. Soc., xxi, 1912, No. 2, p. 701-705.*)

JOHNSON, D. S. . Studies in the development of the *Piperaceæ* I. (*Journ. Exper. Zool., ix, p. 715-749, figs. 1-71, 1910.*)

KAWAMURA, S. . On the cause of the flowering of bamboos. (*Bot. Mag. Tokyo, xxv, 1911, p. 273-269.*)

KIRTIKAR, K. R. . A note on *Trichosanthes dioica* Roxb. (*Journ. Bombay Nat. Hist. Soc., xxi, 1912, No. 2, p. 700-701.*)

KNUTH, R. . . *Geraniaceæ.* (*Das Pflanzenreich, 53, 1912, pp. 640.*)

KOEHNE, E. . . Genus *Sorbus* s. str. speciebus varietatibus que novis auctum. II. (*Repert spec. nov. Reg. Veget., x, 1912, Nos. 33-38, p. 514-518.*)

KRÄNZLIN, FR. . Orchidaceæ-Monandræ-Dendrobiinæ und Monandræ-Thelasinæ. (*Das Pflanzenreich, iv, 50, II, B 21 and 23, 1911, pp. 182 and 46.*)

KRAUSE, K. . . Einige neue Araceen aus dem Monsungebiet. (*Bot. Jahrbuch., xlv, 1911, 5, pp. 657-660.*)

KUNDT, A. . . Die Entwicklung der Micro-und Macrosporangia von *Salvinia natans.* (*Beih. bot. Centrlbl., xxvii, 1911, Abt. 1, p. 26-51.*)

KUNZ, M. . . Systematisch-anatomische Untersuchung der Verbenoideæ unter ausschluss der Gattungen *Verbena, Lantana* und *Lippia.* (*Erlangen, 1911, p. 78, with 1 plate.*)

LEHMANN, E. . . *Veronica javanica* Bl. ein Ubiquist tropischer und subtropischer Gebirge. (*Ann. Jard. Bot. Buitenzorg, xxv, 1912, p. 189-201.*)

LIQUIER, O., & TISON, H. Les Gnetales, leur fleurs et leur position systematique. (*Ann. Sc. Nat., xvi, 1912, Nos. 1-3, p. 55-186.*)

LLOYD, F. E. . . Development and nutrition of the embryo seed and carpel in the date *Phœnix dactylifera* L. (*Rept. Miss. Bot. Gard., xxi, 1910, p. 103-164, with 4 plates.*)

MAIDEN, J. H. . A critical revision of the genus *Eucalyptus.* (*Vol. ii, Pt. 4, p. 135-164, with 4 plates.*)

PAX, F. . . *Euphorbiaceæ-Cluytieæ.* (*Das Pflanzenreich, 47, pp. 124, 1911.*)

PEARSON, H. H. W. . On the Microsporangium and microspore of *Gnetum*, with some notes on the structure of the inflorescence. (*Ann. Bot., xxvi, No. 92, 1912, p. 603-620, with 2 plates.*)

PRAIN, D. . . A review of the genera *Erythrococca* and *Micrococca*. (*Ann. Bot., xxv, 1911, p. 575-638.*)

ROLFE . . . *Bulbophyllum* (*Oxysepalæ*) *congestum* Rolfe in "New Orchids, Decade 38." (*Kew Bull., 1912, No. 3, 131-132.*)

RAUBACH, S. . . Die Entwicklung der Samenknospe bei den Crassulaceæ. (*Recueil Trav. Bot. Neerland, viii, 2, 1911, p. 182-200.*)

SCHINDLER, A. K. . Lespedezæ novæ et criticæ. 1. (*Repert. spec. nov. Reg. Veg., ix, 1911, Nos. 32-34, p. 514-523.*)

SCHLECHTER, R. . *Lecanorchis Ridleyana*. (*Repert. spec. nov. Reg. Veg., ix, 1911, Nos. 27-31, p. 428.*)

SCHMIDT, R. . . Beitrage zur flora sanskritica. (*Zschr. deutsch. morgenländ. Ges., lxv, 4, 1911, p. 729-758.*)

SCHOTTKY, E. . Die Eichen des extratropischen Ostasiens und ihre pflanzengeographische Bedeutung. (*Bot. Jahrbuch., xlvii, Pf. 5, 1912, p. 617-708, with 2 plates.*)

SKAN, S. A. . . *Perovskia atriplicifolia* Benth. (*Bot. Mag., Tab. 8441, June 1912.*)

SMITH, W. W. . . Diagnoses of new species from Burma and Assam, in "Decades Kewenses." (*Kew Bull. No. 8, 1911, p. 344 and p. 347, and No. 4, 1912, p. 198.*)

,, . . New Burmo-Chinese species of *Didymocarpus*. (*Notes from Roy. Bot. Gard. Edinburgh, No. xxiv, January 1912, p. 149-154, with 5 plates.*)

,, . . New species of *Craibiodendron*. (*Notes from Roy. Bot. Gard. Edinburgh, No. xxiv, 1912, p. 157-160, with 2 plates.*)

STILES, W. . . The *Podocarpeæ*. (*Ann. Bot., xxvi, No. 92, 1912, p. 443-514, with 3 plates.*)

THODAY, M. G. . Note on the inflorescence axis in *Gnetum*. (*Ann. Bot., xxvi, 1912, p. 621-622.*)

TURRILL . . *Fimbristylis Lacei* in "Decades Kewenses," lxii. (*Kew Bull. No. 8, 1911, p. 348.*)

II.—ECONOMIC BOTANY.

Part I.—AGRICULTURAL BOTANY.

BY

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The present report deals with the progress of Agricultural Botany in India during the year ending June 30th, 1912, and is confined to the results actually obtained. All references to current programmes of work are omitted as these are to be found in the *Proceedings of the Board of Agriculture for 1911*, which has already been published. In the present paper, the subject of seed distribution in India has been dealt with in a separate section, in order that the significance of the great progress made in this direction by the Agricultural Department may be appreciated. A list of papers published during the year is appended.

I. SEED DISTRIBUTION.

Since the foundation of the Agricultural Department of India in 1905, a considerable amount of attention has been paid to the improvement of the cultivated plants of the country. New crops have been introduced and better varieties of existing staples have been brought to the notice of the people, coupled often with improved methods of cultivation. The success of these efforts has in turn raised the question of the best means of maintaining and distributing pure seed of improved varieties of crops and this matter was one of the subjects discussed at the recent meeting of the Board of Agriculture held at Pusa in November 1911. The report of the Committee, which was adopted by the Board, is published in the *Proceedings of the Board of Agriculture for 1911*, and deals with the methods of obtaining improved varieties, the testing of varieties, the maintenance of pure types, the distribution of seed to cultivators and with the marketing of the produce. In this work stress was laid on the importance of natural cross-fertilization in crops like cotton and also on the maintenance in pure culture, by the Botanist in each Province, of a collection of the improved types introduced by the local Department. This collection will serve both as a source from which pure seed can be obtained for re-stocking the seed farms and also for the use of investigators in other Provinces. In the distribution of

seed to cultivators it was recommended that the following main principles should guide the work of the Agricultural Department:—

1. The desirability of concentrating the efforts of the Department on one or two well-defined problems at a time rather than wasting its resources on indiscriminate seed distribution.

2. The desirability of confining the work of seed distribution in any one tract as far as possible to one sort and of systematically replacing existing mixtures by this pure type. This is particularly necessary in the case of cross-fertilized plants where degeneration through vicinism is of such great importance. The distribution of one sort only has the further advantage of creating large supplies of one particular type and thus forming a trade centre for this produce and attracting buyers.

3. The necessity of utilizing to the utmost the present staff and resources of the Department and of supplementing this by enlisting the assistance of leading agriculturists in the work of seed growing and seed distribution in the tracts concerned.

This discussion of the general subject of seed distribution in India by the Board of Agriculture by no means implies that nothing useful in this direction has been accomplished. On the contrary, the results already obtained are most gratifying and the present opportunity is taken of drawing attention to the most important. The crops in which most progress has been made are cotton and wheat and these are dealt with in the following paragraphs.

Cotton. The distribution of improved seed of a crop like cotton, in which natural cross-fertilization is common, in such a manner that the improvement in the staple can be maintained permanently is a problem of the greatest interest in agricultural science. On this account the efforts of the Agricultural Department in this direction are described in some detail. It is clear that if this work is to be of lasting benefit to India the present cottons in any tract must be entirely replaced by one kind, which breeds true to type, in order that the results of vicinism may be prevented and the mixing of seeds at the ginneries rendered impossible.

The improvement of the cotton crop in Madras is one of the chief features of the work of the Provincial Agricultural Department. Not only have selection methods been applied successfully to the local cottons, but an exotic cotton, known as Cambodia, has been widely taken up by the cultivators.

In the selection work the results obtained by Mr. Sampson with Karanganni cotton in Tinnevelly are the most interesting and the most

important. This work was commenced at the Koilpatti farm some years ago and the area now under the improved cotton is upwards of 80,000 acres. The methods first adopted in the improvement of Karanganni cotton come under the term mass selection, that is to say, the culture was started from several plants. These were selected for their shape and bearing power from the general farm crop. In the third year, the seed was issued to contract growers who cultivated it under instructions from the Department. The whole crop was then sold back to the Department, who ginned the *kapas* and next year distributed the seed to depôts in the black cotton soil villages where it was sold to cultivators. These depôts are selected every year and the depôt is moved to a fresh place as soon as Karanganni cotton has been established as a pure crop. In this way the whole area suited to this cotton will be worked over and the existing cottons will be replaced by the improved kind. Recently the methods of selection have been improved at Koilpatti and at the present time the cultures are started from one plant. Such pure line cultures have already reached a field scale and during the present year one of these will be grown on a seed farm. The method of conducting the pure line cultures is as follows: In the second year culture the crop from each plant is collected separately and the lint is examined for twist, evenness, length and fineness and the ginning percentage is also determined. The best and most even plants only of this culture are taken for seed and these are grown as a field crop on a plot one-tenth of an acre in area so that the behaviour of the selection under ordinary field cultivation can be estimated. If the crop is even and suitable in the third year it is planted on an acre plot, after which the cotton is sampled and tested, and, if suitable, carried on to a seed farm. At each stage selections which prove undesirable are discarded and an approximation to a pure culture is obtained in this way and cross-fertilization is to a great extent prevented. Mr. Sampson states that cross-fertilized plants disclose themselves by the following characters: by increased vigour; by increased length of the staple; by increased difficulty in ginning—a selection in which there is difficulty in removing the lint from the seed is always open to suspicion. Variation in the colour, shape and fuzziness in the seed of the progeny of a selection is also a useful indication of natural crossing. The area of the seed farms in Tinnevelly under Karanganni in 1910-11 was 574 acres which gave seed enough for 11,200 acres and it was sold for Rs. 10 per 250 lbs. There was great competition for the seed and it is interesting to note that the Tuticorin Chamber of Commerce states that the improvement in the quality of this cotton is still maintained. As the selection methods at the Koilpatti farm progress there is little doubt that

still better cotton will be produced for the seed farms and in this way successive waves of cotton will proceed outwards from the agricultural station resulting in the establishment of a definite improvement.

In the Northern Circle of the Madras Presidency similar methods of selection and seed distribution with cotton have been started, the preliminary results of which appear to be of considerable promise.

In the case of Cambodia cotton the results obtained in Madras are, on the whole, not so satisfactory as with Karanganni. Cambodia cotton, which is grown only on irrigated garden lands, continues to spread and in the south of the Presidency the crop is estimated at 80,000 bales as against 33,000 bales the previous year. In addition it has been tried further north in Bellary, Kurnool and other Districts and has been a success everywhere. Over 31,000 lbs. of seed were sold by the Department last year and a still larger stock will be held in future. The yield per acre is as good as ever but the price has dropped to the level of Tinnevelly or even lower. This is said to be due not only to the fact of the cheapness of long stapled American, with which Cambodia competes, but also to a deterioration in quality of which most of the mills complain. The subject has received the careful attention of the Director of Agriculture who states that this deterioration is due to some extent to fraudulent admixture with country cotton, but mainly to the carelessness of the ryot who sows mixed seed and who will not trouble to eradicate the country cotton plants from his Cambodia crop. Some of the deterioration may be due to fraudulent admixture with country seed by the private growers who are growing the Cambodia mainly for seed purposes. The Madras experience with Cambodia is not surprising considering the rapidity of the spread of this cotton by private agency and the fact that most of the seed supply was not controlled by the Agricultural Department. It is a valuable lesson to all concerned with the establishment of high quality cotton in India. To bring about any permanent improvement in such cottons it is necessary to replace systematically all the existing cottons in a tract by one type as is being done in Tinnevelly. This replacement to be effective must obviously be controlled by the Agricultural Department and it is clear that this will take time, especially when the size of the staff and the means of the Department are considered. There must always be a risk of fraudulent adulteration of seed if the seed supply is not under strict control and it would seem to be better to work in one or two Districts at a time in future than to allow the cotton to spread itself. Only in this way can the consequences of natural crossing, of mixing of seed at ginneries and of fraudulent admixture be prevented.

In the Central Provinces, the chief centre of cotton seed distribution is situated at Akola in the middle of the cotton tract, where the work has been organised by Mr. Clouston, Deputy Director of Agriculture, Southern Circle. The principal types distributed have been obtained by selection from the Berar *Jari* and high quality long stapled cottons like *Buri* are distributed only to rich village lands and in those areas where cotton is generally affected by wilt. The selected constituents of the *Jari* mixture are short stapled cottons, characterised by high yield, high ginning percentage and robust growth under ordinary conditions and it has been found that these types pay the cultivator best. From the Akola farm as a centre, a system of seed distribution has been developed by Mr. Clouston on the following lines. Leading landowners, who are also members of the Agricultural Associations, are selected as suitable men to look after the local private seed farms and at the beginning the Government guaranteed to these men to make up any loss resulting from the improved methods of cultivation and the growth of seed which the Agricultural Department recommended. The selected seed from the Akola farm is sold to these private seed farms and the owners themselves arrange for its sale and distribution. The supervision of the Agricultural Department is confined to cultivation, ginning and advertising the seed in the monthly vernacular journal, which has a circulation of about 6,000 copies. The chief difficulty experienced has been that of getting the seed ginned at the proper time and of preventing mixture of kinds during the process. The number of these seed farms in 1911 was 42, and it is estimated that upwards of 250,000 lbs. was distributed through their agency. The number of farms has since been increased to 120, and it is expected that 600,000 lbs. of seed will be distributed when the present crop is picked. The Akola farm, which supplies the private seed farms, was inspected by Mr. Arno Schmidt, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, in 1911, who stated:

"The whole farm, in consequence of its sound management, does not only act as a nucleus for the other seed farms and as a demonstration to the many farmers who visit it, but it also realises a very handsome profit. I cannot recommend the farm too highly as an example well worth emulation in other Provinces; it certainly is the best and most effective seed and demonstration farm I have seen in India."

A similar system of seed distribution of the Akola cottons is being developed in the Nimar District of the Central Provinces by Mr. Evans.

It will be seen that the methods of cotton seed distribution in the Central Provinces and Madras have one important difference. In Madras,

the seed is grown for the Agricultural Department under contract and comes back every year to stock the village depôts. In the Central Provinces, private seed farms are supplied from the Government farm and the work of seed distribution is in the hands of the seed growers themselves. It will be interesting to watch the progress of these two systems and to see which is the more effective in bringing about a permanent improvement in the cotton crop.

In the Bombay Presidency, the distribution of improved cotton seed has not made the same progress as in the case of Madras and the Central Provinces. In Guzerat, the improved cottons obtained by the Agricultural Department are not markedly better than those already grown by the cultivators. Some types however have been obtained which the trade is prepared to purchase at a premium of five per cent. over the prevailing bazar rate for local Broach cotton. The distribution of these improved cottons is being arranged for through the Bombay Cotton Trade who have formed a syndicate to buy up at a premium of 5 per cent. all the seed cotton which is produced by cultivators in the Surat District from seed supplied by the Agricultural Department. The syndicate also provides facilities for the separate ginning of this seed cotton under departmental supervision and the return of the seed to the Agricultural Department for redistribution. The seed is then given out to groups of villages where only this kind is grown and the harvest is taken over by the ginneries as described above. In the present season arrangements have been made to distribute sufficient seed to sow 10,000 acres.

In Dharwar, Broach cotton has been found to do well, but after a time the seed deteriorates, so that the best arrangement has been found to be to import fresh seed from Guzerat each season for the cultivators. This can be done at a price of Rs. 2 per maund compared with Rs. 1-4 for local *Kumpta* cotton seed.

In Sind, under present irrigation conditions, the efforts of Mr. Henderson, the Deputy Director of Agriculture, in improving the local cotton are confined to the growth on a large scale of American Upland. Arrangements have been made to sow 4,000 acres of this cotton and a Bombay syndicate has been formed to finance the growth, to erect gins and to sell the product as graded American Upland. This cotton is worth 25 per cent. more than the local staples and will be grown largely in a part of Sind in which cotton is not at present cultivated. There will, in these tracts, be no possibility of admixture or crossing with local kinds.

In the United Provinces, progress has been made in cotton seed distribution by Dr. Parr, from the Aligarh farm. From the local cotton

a white flowered type has been isolated which is characterised by a high yield of *kapas* and a ginning percentage of 40 per cent. The staple however is somewhat shorter and coarser than the local yellow flowered kind. This disadvantage in character of lint is however more than made up for by the increased yield and high ginning percentage. About two thousand acres of the white flowered cotton are being sown this year and the crop will be purchased by Government so that the seed will be available to sow 30,000 acres next year. A great demand for seed has arisen and there is every prospect that this cotton will be established in the neighbourhood of Aligarh.

A beginning has also been made at Cawnpore by Mr. Burt where a new farm has been started for the supply of cotton seed. The white flowered cotton from the Aligarh farm is being grown for distribution to cultivators. About 1,500 acres of land round Cawnpore have also been sown with Dharwar American cotton, which will be bought by a Cawnpore mill at a premium.

During the past year the report of Mr. Arno Schmidt, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, on his visit to the cotton growing tracts of India, in December 1911 and January 1912, has drawn pointed attention to the work on the distribution of the seed of improved cottons in India. The report, considering the short period of the Secretary's visit and the many-sided aspects of the subject dealt with, is a very valuable one and is certain to lead to good results. The Secretary was particularly impressed by the seed distribution arrangements at Akola and recommended that "The system adopted by the Central Provinces of having two or more 'nucleus' seed farms owned by Government and a large number of smaller seed farms owned by intelligent cultivators, spread all over the Province, is to my mind the most essential means for improving the staple and of increasing the yield. Such seed farms are especially required in the Bombay Presidency, in the Punjab and the United Provinces." In considering this recommendation it must be borne in mind that the chief cotton distributed from Akola is a short stapled heavy yielding kind with a high ginning percentage which has been found suitable for the tract in question. *The improvement aimed at is one of yield and no question of quality is involved.* Consequently admixture of this cotton with other kinds and a certain amount of natural crossing are not so important as in the case of the distribution of selected Karanganni in Tinnevelly, of Cambodia in South Madras or of improved Broach in Guzerat. In all these latter quality of the fibre is the main consideration and mixing at ginneries and natural crossing are far more

important. The object at Akola is not the same as in the other tracts referred to and a system of seed distribution that suits the short staple cotton of the Central Provinces may not be the best in Madras. It may be much the best policy for Madras in the long run to control the seed distribution till the whole of the existing cottons of particular tracts are replaced by one improved kind. If the seed of improved long staple kinds is grown by private seed farms it is possible that adulteration will be practised and the degeneration of the staple will only be a question of time—a state of things which apparently has already begun in Madras with Cambodia. Another matter in connection with seed distribution mentioned by Mr. Arno Schmidt refers to the establishment in India by the English spinners of agencies for the buying, ginning and export of long stapled cotton. This is considered to be unnecessary as it is stated that the same result can be more easily achieved by co-operation with the Indian mill-owners. It is pointed out that long stapled cotton grown in India need not necessarily be purchased by Lancashire. Any of this cotton sold will naturally go to the highest bidder and whether it is consumed by Lancashire, India, Japan or the Continent does not matter as a corresponding amount of American cotton will be set free. In the whole report the work done by the Indian Agricultural Department on cotton is dealt with with great fairness and full credit is given for what has already been done. The Committee of the International Federation of Master Cotton Spinners' and Manufacturers' Associations considered Mr. Arno Schmidt's report at a meeting held at Salzburg on May 13th and 14th, 1912, and referred to the work on cotton of the Indian Agricultural Department in their second resolution as follows:—

> "This Committee expresses its high appreciation of the work undertaken by the various Agricultural Departments in India and respectfully urges on the Secretary of State the absolute necessity of strengthening the European staff in every Province if the measures for the extension of cotton cultivation that have been introduced are to have any prospect of success."

Wheat. In the case of this crop, in which self-fertilization is the rule, the question of seed distribution does not present the same difficulties as have to be overcome in the case of cotton. It is only in irrigated tracts like the Punjab, where the air is dry, that natural cross-fertilization in wheat is of sufficient importance to be considered in the work of seed distribution. Admixture of kinds in wheat at threshing time can be to a great extent prevented by using a separate threshing floor for each kind or by the use of pucca floors which can be swept clean

between the kinds. Even when admixture takes place the cultures can be started afresh from a single plant and a large quantity of pure seed is very soon obtained. Further, the amount of seed per acre in wheat is relatively large so that the area of the seed farms is not so large as in the case of cotton. The only problem in wheat distribution in India after the best wheats for any tract have been obtained is the question of grades. To accomplish the greatest possible improvement in wheat production in India it is necessary to establish definite grades of wheat of known quality in the various tracts, so that these grades may become well known in the markets of Europe. The position of Canadian wheats on the Home market is largely due to the grades which have been established and which are maintained by the assistance of Government. To establish such grades in India it will be necessary to confine seed distribution in the various tracts to wheats of one or two grades and to replace the existing crop by these grades. Such wheats should be suitable for the export trade and also for local consumption and it will be necessary to operate with a very small number of wheats which would fall into two grades at the most.

In the wheat growing areas of the northern portion of the Central Provinces progress has been made by Mr. Evans in improving the grade of soft white pissi wheat which has been for some years a feature of this tract. The improvement consists in extending the cultivation of selected white pissi and keeping it free from red and other impurities. The work is directed from the Powarkhera farm near Hoshangabad which supplies forty private seed farms in the Northern Circle. These seed farms are grouped round some important market and the growth, threshing and storage of the wheat is supervised by the Agricultural Department. One essential condition for each private seed farm is the provision of a separate threshing floor for this wheat. The Government has the first refusal of any seed not required by the grower and it is proposed to re-stock all the seed farms every fourth year from Powarkhera. In this way it is expected that a grade of improved white wheat, practically free from admixture, will be established in this tract to the benefit both of the cultivator and the trade.

A beginning has been made in the distribution of the strong wheats of high yielding power produced at Pusa. These were tried last year on a large number of estates in Bihar and about 1,500 acres were grown. The results were so satisfactory that seed farms, 500 acres in extent, under the supervision of the Imperial Economic Botanist have been started on three estates. The seed is being grown by the Planters concerned under directions from Pusa and the farms will be re-stocked from

time to time from Pusa. As soon as sufficient seed is available for the market a grade of superior strong white wheat will be offered to the trade. In the various Provinces where Pusa wheats have been tried with success the distribution of seed will naturally be in the hands of the Provincial officers concerned. Thus in the United Provinces Mr. Leake is growing large quantities of seed at Cawnpore and Aligarh and in the Central Provinces Mr. Clouston is developing the work from Tharsa and Raipur. The investigations at Pusa will be confined to the production of new kinds and to the growth of sufficient seed for re-stocking periodically the various seed farms in Bihar and other Provinces.

Besides wheat and cotton a considerable amount of seed of some of the other cultivated crops of India has been distributed from the various Government farms, but the quantity has not been beyond the means of these farms and in no case has it been necessary to establish special seed farms as in the case of cotton and wheat.

II. INVESTIGATIONS.

Sugarcane. The present position of the Indian sugar industry has been the subject of considerable discussion during the year. The steady increase in the yearly imports of foreign white sugar into India, combined with its low price, has resulted in the decline of the area under cane and in the decrease of the number of sugar mills and refineries in the most important sugar tracts of India. In the quinquennial period ending 1889, the import of foreign white sugar was 79,638 tons while at present it is over 700,000 tons per annum. Attention was called to the subject at the meeting of the Imperial Legislative Council in Calcutta in March 1911, and at the recent Agricultural Conference held at Allahabad. In consequence, the present position of the Indian sugarcane industry and the means by which it can be improved were exhaustively discussed, at the instance of the Government of India, at the recent meeting of the Board of Agriculture in India, and a detailed programme of future work was prepared.

From the botanical point of view the main recommendation of the Board of Agriculture related to the establishment of an acclimatisation and cane-breeding station in Madras which it was suggested, should be placed under an Imperial officer. This proposal was subsequently adopted by the Government of India and sanctioned by the Secretary of State and a large grant for the purpose has been placed at the disposal of the Government of Madras under whose direction the station has been placed. It is proposed to found the sugarcane breeding station at Coim-

batore, and, although final orders have not as yet been issued, a certain amount of preparatory work has been accomplished by Dr. Barber. About 90 kinds of cane have been collected for comparison and these have been somewhat exhaustively studied. The attempt to raise seedling canes in India has been renewed and the reasons for former failures in this respect have been investigated. It has now been discovered that these failures are almost entirely due to the fact that most of the indigenous canes, as far as examined, do not form fully developed stamens, the rest of the flower being apparently normal. One native cane and two introduced ones have, however, been thus far found to contain a number of open anthers in the flowers and, acting upon this clue, a considerable number of cane seedlings have been already produced. It is anticipated that there will be no further difficulty in this matter, once the sugar station is sanctioned. As might have been anticipated, these seedlings vary considerably among themselves even when of the same parentage, and the next step in the enquiry will be the far more difficult work of selection and the discovery of criteria by which unprofitable forms may be eliminated before too much time is spent upon their study. A more detailed description of the work thus far done has been prepared for the *Agricultural Journal of India*. The lines on which it is proposed to conduct the station are as follows:—

(1) The collection of all canes growing in India, their comparison and classification, (2) a study and comparison of the cane-growing tracts of India, with special reference to climatic conditions and agricultural practices, (3) such study of the anatomy and physiology of the sugarcane plant as circumstances may demand, (4) the introduction of as many canes from other countries as possible, with special reference to the requirements of Northern India, (5) the raising of cane seedlings and the selection of such as appear to be of value in the same tract, (6) the study of the flowers, growth and life-history of the wild Saccharums of India.

Progress continues to be made in Madras in the successful introduction of new canes. In the South Arcot District the Red Mauritius variety continues to make rapid progress. Here, as in the Godavari delta, the local canes have disappeared, no less than 96·2 per cent. of the area under cane in South Arcot last year being Red Mauritius. The Director of Agriculture of Madras writes: "From experience gained in South Arcot it may now be stated confidently that, with the superior canes now available, and good cultivation and management, India can produce

refined sugar at a price capable of competing with Java sugar. Large areas of suitable land with an ample supply of subsoil water being available, we may expect to see South Arcot become the leading centre of the sugar-industry in Southern India." As an example of the spread of Red Mauritius cane among the Madras cultivators the following figures showing the progress in the vicinity of Nellikuppam speak for themselves:—

				Acres.
1907	(Red Mauritius canes from Melrosapuram)	. . . .		...
1908	Do.	do.	do.	145
1909	Do.	do.	do.	409
1910	Do.	do.	do.	876
1911	Do.	do.	do.	2,250

In the United Provinces the *Saretha* variety (a thin cane), which has done best at Aligarh, is being distributed to the cultivators and around the same centre some of the thick Mauritius canes are replacing the local varieties of thick cane grown for chewing purposes.

In selecting new canes for tracts like the alluvium of the Indo-Gangetic plain, where the monsoon is followed by cold weather of considerable intensity, the recent work of Mr. Somers Taylor at Sabour is of great interest and value. This observer, in a recent paper published in the *Agricultural Journal of India*, has drawn attention to the consequences of the great difference in growth conditions between tropical islands like the West Indies and Java and sub-tropical regions like the plains of India. In the former, both growth and ripening are practically continuous and there is, as it were, no hurry for the canes to ripen. In tracts like Bihar however the cold season cuts short growth and in many cases interferes with the ripening process. What is wanted under such conditions are canes which can ripen properly in the available growth period and for this rapidly maturing varieties are essential. These investigations also show the need of chemical control in variety trials of canes in India and the discovery of some easy method of determining when the canes are at their best.

At Sabour, Mr. Woodhouse has made some interesting observations on the flowering of the sugarcane. While many varieties flowered in 1911, in only one case were the anthers observed to dehisce and even here no seedlings were observed.

Wheat. Progress continues to be made in wheat investigations in India and during the year several papers have been written which are now in course of publication.

In the United Provinces, Mr. Leake has summed up the results of his experiments with this crop at Cawnpore in a paper now in the press. At this station it has been found that under canal irrigation high grain quality is easily produced provided the preliminary cultivation is thorough and care is taken in the regulation of the water supply. Further, crops of as much as 2,500 lbs. to the acre have been grown with much less water than is used by the cultivators. These results are of the greatest value as they show that high quality in wheat is possible in the alluvium with canal irrigation and that a considerable saving of canal water can be made in the growth of this crop.

An important stage has been reached in the experiments on the influence of environment on the quality of wheat and the results, which include the crop of 1911, have been submitted for publication. In these experiments wheats of widely different quality, including strong free milling wheats, have been grown at many stations in the plains and also on the black soils of Peninsular India. The circumstances under which the wheats have been grown have differed widely and the range of conditions have been as great as would occur if the same wheat were grown by the best and the worst cultivators. It has been found that the weak wheats have always remained weak but their milling and baking qualities have been improved to some extent by cultivation. Strong wheats with good milling qualities have, on the other hand, been found to retain their strength and free milling nature both under canal irrigation in the alluvium and also as a dry crop on the black soils of Peninsular India. Even when grown after rice the same year and with inadequate cultivation the strongest of the wheats grown always showed its superiority in the milling and baking tests. These results are important in the improvement of the wheat crop in India as they indicate vast scope for progress in the future even after the highest possible yield has been realised. Where the limit of yield has been reached there will still remain the question of quality. These experiments also throw light on the relations between yield and quality in wheat. It was found in the case of any particular wheat that the conditions which produce the highest yield are those which also produce the best quality. Further in the same wheat high yield and high quality can be combined. A cultivator therefore, who wishes to obtain the greatest financial return for his labour, should grow to perfection a wheat which combines high yield and good grain qualities. When this is accomplished Indian wheats will be second to none in the markets of the world. During the investigations of the relation between yield and quality two adverse factors in wheat production in the alluvium were investigated—water-

logging during the monsoon and late cultivation. Both influenced the yield and to some extent the quality. Waterlogging for a month only reduced the yield about fifty per cent. while late cultivation was responsible for a diminution of about one-third the total crop. Another interesting fact arose out of these experiments, namely, the change of consistency in the same wheat when grown in different places and under different conditions. In general the consistency of the wheats grown varied greatly with environment. A few hard wheats however showed a tendency to remain hard while several soft wheats always remained soft and never hardened. It is possible that these constant soft wheats are always characterised by poor milling qualities, a point which is now being investigated.

In the wheat breeding experiments at Pusa, an account of which is now being published, several interesting results have been obtained. The wheats employed in this work, which was stated in 1906, have been throughout pure line cultures, that is to say, the parents were originally grown from a single ear. In this way only is there any prospect of obtaining results of permanent value in hybridization work. In addition the number of plants used in the second generation has often been over one thousand in number. The results confirm and extend those obtained at Svalöf and show that such apparently simple characters as colour of grain, presence of awns, felted chaff and resistance to rust are often exceedingly complex and involve the existence of several factors. The number of these inheritable factors in wheat is considerable and this fact explains the very large numbers of different types met with in cultivation. In breeding new forms it is essential that the gametic constitution of the parents should be known and the number of factors determined. Indeed the subject is so complex and the number of plants necessary is so large that it is desirable to restrict all hybridization work in the Agricultural Department to a few centres in India where the requisite facilities and supervision can be provided. It is doubtful whether any useful results will ever be obtained unless these conditions are fulfilled.

During the past year the wheats produced at Pusa and the methods of cultivation for this crop worked out at this station have been tried at many centres in India. The detailed results of this work have already been brought to the notice of the Government of India in the writer's last annual report so they need not be repeated here. It is sufficient to state that the results obtained in Bihar, the United Provinces, the Punjab and the Central Provinces have been most satisfactory and that the demand for seed which arose from these trials could not be met,

Fruit. Considerable attention is now being paid to the improvement of Indian fruit—an important matter in a country like India with such a large vegetarian population. In Bombay, Mr. Burns has devoted a considerable amount of attention to various questions relating to fruit growing at Ganeshkhind near Poona and also at Bassein in the Konkan. The methods of pollination of the mango are being investigated and it appears that the flowers set under bag without the intervention of insects. In the case of the papaya the work done so far indicates that parthenogenesis occurs in this crop. Several other questions relating to fruit are being taken up which promise to yield interesting results.

At Saharanpur, Mr. Hartless has devoted attention to several questions relating to the mango crop. The well thrown deleterious effect of damp and rainy weather at flowering time on the setting of the fruit is said to be due to the influence of humidity on the pollen. Hence early and late flowering kinds should always be grown so as to increase the chances of successful pollination. In connection with the work on polyembryony in mangoes, observations on this subject have also been made at Saharanpur. So far as the observations go the Indian grafted mangoes show no polyembryony although this condition has been found in seedlings.

In the Punjab, Mr. Milne has devoted attention to the culture of dates which is being started by the Provincial Agricultural Department from Multan and Muzaffargarh as centres. A detailed paper giving information on the cultivation and the conditions requisite for success has been issued.

At Quetta, a new fruit experiment station, 25 acres in extent, has been started during the year and considerable progress has been made in laying this out and in providing buildings and an artesian water supply. During this preliminary work attention has been paid to the best methods of packing fruit for long journeys under Indian conditions. Returnable packages have been found impracticable for long distances on account of the cost of the return journey and of the frequent overcharges made by the Railway Company. Loss by thefts in transit are common, but it should be possible to put an end to these practices if the staff concerned with these packages are made jointly responsible. Cheap light non-returnable packages have been found most useful and a large number of these were put on the market at Quetta during the present summer. Over one thousand peach boxes have been sold, many of which have been purchased by the Indian dealers. A bulletin is in preparation on this subject as it is felt that great improvements in the transport of

fruit are immediately possible in India without waiting for cold storage vans.

Cotton. Attention is being paid to the inheritance of flower colour in cotton at the Dharwar and Surat farms in the Bombay Presidency. An account of this work is to be found in the recent reports issued from these stations. At Cawnpore, Mr. Leake has continued his important investigations into the inheritance of characters in cotton and considerable progress has been made in the isolation of new kinds. A detailed account of these researches was given in the last report. Recently another paper has been published at this centre dealing with the characters and classification of the cottons obtained from Persia and Eastern Asia. A beginning has also been made in cotton breeding work at Coimbatore and the Madras Government proposes to appoint an Assistant Economic Botanist who will be employed, to a large extent, with the improvement of this crop.

Miscellaneous. Messrs. Finlow and Burkill have published an account of their investigations on the inheritance of the red colour in the common jute plant, *Corchorus capsularis* L., and state that self-fertilization is the rule in this species in India. Under the most favourable conditions for crossing the amount is said not to exceed two per cent., while in ordinary circumstances it may be much less and may not exceed 0·2 per cent. It seems probable that the colour factors in jute are not simple, as the authors suppose, but complex and the published figures point to the existence of two red factors at least. At Coimbatore, Dr. Barber has paid some attention to the types of *Hibiscus cannabinus* and the fibre of the various varieties has been compared. An account of the last year's working of the flax experiment at Dooriah in Bihar has been published by Mr. Vanderkerkhove in Pusa Bulletin No. 30. A profit of Rs. 63 per acre was obtained, but in spite of this satisfactory result planters are not inclined to take up the growth and manufacture of the fibre. Mr. Coventry, in an introduction to this paper, states that the disinclination of the planters to embark in this industry "seems chiefly due to the large amount of expert knowledge and capital required on the industrial side which are not easily commanded by the grower and there is, therefore, a difficulty in combining the two undertakings." In future, the growth of the flax and the factory aspects will be kept separate. Dr. Barber has published an interesting account of the sensitive plant (*Mimosa pudica*) in Coorg, where it is regarded as a dangerous weed. The methods of eradication are discussed and an account of various experiments for destroying the weed, including spraying with sodium arsenite, are given. A new coffee experiment station for the

investigations are already in progress. An account of the Italian millet (*Setaria italica*) in Bengal, in which the pollination mechanism and the occurrence of natural crossing have been worked out, has been published by Mr. Woodhouse and Babu A. C. Ghosh.

PART II.—FOREST BOTANY.

BY

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Œcology of sal.—This work was continued on the lines indicated in last report, publication having been deferred in order to include the results of observations made in the Dehra Dun sál forests by the Botanist during the year and the soil analyses and water determinations carried out by the Forest Chemist in connection therewith. The results will shortly be sent to press, but it may be mentioned that the work done shows that sál seedlings die when the moisture-content of the soil in contact with their roots falls below 1 per cent. and 9 per cent. respectively in sand and heavy loam. It was pointed out in a previous report that the species of grass dominant in a particular locality is frequently an accurate indicator of the prevailing conditions of soil and moisture, and that where *Saccharum Munja* is dominant the locality is suitable for dry-miscellaneous-forest species, whereas the dominance of *Saccharum Narenga* indicates soil and moisture conditions suitable to sál. In connection with this it is interesting to note that a series of soil samples selected during the year in local grass-lands of these two species in June, (*i.e.*, in the critical period before the break of the rains), showed a moisture content at the depth of 1′ 6″ (which is the average depth reached by the roots of sál seedlings in their first year) of 0·8 to 1·6 per cent. in the case of the former species and 16 to 19 per cent. in case of the latter. This clearly indicates the *primâ facie* unsuitability of grasslands of *S. Munja* for the growth of sál. The work done up to date will be shortly published and an extended series of experiments has been arranged for the further study of soil-moisture and light and the effect of these factors on the healthy development of sál.

Forest Grasses.—The study of Forest Grasses has been continued on the following lines:—

(1) The publication of descriptions and illustrations of the species likely to be most valuable, on account of their known

economic value, on account of their dominance over large areas, or because they occur constantly in admixture with valuable species and are likely to be confused with them. The first object of such publication is to focus attention on the more valuable species and to facilitate their identification.

(2) The determination of the best treatment to apply to forest grasslands with the object of realising, on the one hand, the best economic return from the grasses and, on the other hand, of facilitating the afforestation, with valuable trees, of those grasslands not required for the production of grass.

(3) The determination, in collaboration with other specialists, of the economic value of the species dealt with for fodder, paper-pulp and other purposes.

During the year descriptions and illustrations of the following species were published:—*Saccharum spontaneum* Linn., *S. Munja* Roxb., *S. Narenga* Wall., *Erianthus Ravennæ* Beauv., *Imperata arundinacea* Cyrill., *Triraphis madagascariensis* Hook. f., *Aristida cyanantha* Steud., *Andropogon monticola* Schult. The principal taxonomic and œcological results included in this publication have been briefly noted in the reports of previous years. The study of the following species on similar lines to the above was commenced during the year:—*Anthistiria gigantea* Cav., *Eragrostis cynosuroides* Beauv., *Phragmites Karka* Trin., *Arundo Donax* Linn., *Ischœmum angustifolium* Hack. and *Vetiveria zizanioides* Stapf.

Development of culms.—The importance of studying the life-history and development of the various species is shown by the fact that in some of the larger species which are likely to be most valuable for paper-pulp, *e.g.*, *Saccharum Munja* Roxb., the culms, instead of being annual, require 2 years for their full development and consequently such species must be worked on a rotation and not cut annually, if a full and regular yield is required. In addition to this, the liability of a species to damage, *e.g.*, by fire, depends on the period required for the development of the culms and on the condition of growth at the season when fires usually occur. It is obviously of importance, therefore, to discover a method by which the period required for development can be readily ascertained by an inspection of the culm and it has been found that there is a definite relation between the number of nodes and leaves produced by the culm and the number of months constituting its period of growth,

although this varies in different species. During the year a detailed study in this connection was made of the development of the culms of wheat (*Triticum sativum*) which is a convenient type of an annual grass and the results will be published next year. Notes also on this point have been given regarding the species mentioned above, of which descriptions have been published during the year and it is hoped that a generalisation on this point will soon be possible, covering (1) annuals, (2) perennials with annual culms with one period of growth, (3) perennials with annual culms with two periods of growth and (4) perennials with biennial culms. It may be noted incidentally that this point is not only of importance in the management of grasslands, but has a direct bearing on the question of selecting suitable types of an agricultural cereal, such as wheat, for cultivation in tracts with a particular climate and length of growing season.

Distribution of species and possible yield.—From an economic point of view it is essential to obtain accurate information regarding the distribution of the chief dominant forest grasses and of the approximate area occupied by them, seeing that, apart from other important points, the yield and possibility of establishing an industry, *e.g.*, for the manufacture of paper-pulp, depends on this. With the object of facilitating the collection of such information the Botanist has identified a number of grasses, which have been sent in by local forest officers, amounting to 150 specimens during the year. A direct result of this work is that local officers in the United Provinces are now preparing maps showing, in each Division, the approximate area occupied by the chief dominant grasses. The map for the Ramnagar Division has already been received and it is hoped that others will shortly follow and that this work will be taken up also in other Provinces. The information supplied by these maps will obviously be of the greatest value in such questions as the determination of the best sites for paper-pulp factories, or for extensive fodder operations, in addition to indicating the chief types of grassland which require separate study by the Botanist.

Value for paper-pulp.—With the object of determining the value of the chief dominant species in North India for paper-pulp, specimens of 22 carefully identified species were submitted to Mr. Raitt during the year for analysis. Those species were especially selected which promised to be of most value on account of their occurring dominant over large areas or constantly in mixture with other valuable species. Mr. Raitt was unfortunately unable to do more

than make a preliminary examination of this material based on simple tests. This examination, however, indicated that 14 of the species, including the very common and widespread *Kans* (*Saccharum spontaneum*), were likely to yield a high-grade pulp and to be of considerable value for the manufacture of high-class paper. Towards the close of the year, however, Mr. Raitt was again able to take up this work and it was then decided to prepare a detailed analysis and report dealing with 10 principal species and a less detailed report regarding 8 subsidiary species. Special attention is being paid to the point as to whether the value of the former is likely to be greatly diminished by an admixture of the latter, the principal and subsidiary species often growing together in nature. It is hoped that this work will be complete by October next.

Burmese Kaing grass.—An interesting point taken up during the year was the identification of the so-called Burmese *Kaing* grass. Specimens sent under this name had been previously examined by Mr. Raitt, who reported that it would form an excellent material for the manufacture of paper-pulp and its correct identification was therefore of importance. Through the kindness of Mr. J. H. Lace, Chief Conservator of Forests, Burma, numerous specimens of *Kaing* were sent to the Forest Botanist during the year which proved that at least 15 species, belonging to the genera *Saccharum*, *Andropogon*, *Anthistiria*, *Arundo*, *Phragmites*, *Rottbœllia*, *Coix*, *Triraphis*, *Thysanolæna* and *Polytoca*, passed under the name of *Kaing*. It is therefore clear that this is merely a general term given in Burma to all large grasses growing in savannahs and swamps, a descriptive epithet often being attached, such as *Paung Kaing*, *Sit Kaing* and so on.

Value for Fodder.—Various experts in India, Europe and America were addressed during the year as to the possibility of devising a system of analysis which could be trusted to indicate the relative fodder-value of our forest grasses. Unfortunately no such method is at present known and the only satisfactory procedure appears to consist in feeding experiments which it is hoped may perhaps be arranged for in co-operation with Pusa.

Miscellaneous Notes.—Miscellaneous notes of interest in connection with the grass specimens sent in by Forest Officers to the Botanist during the year are:—

(*a*) The discovery of *Erianthus elephantinus* Hook. f. by Mr. P. H. Clutterbuck in the Haldwani Division, United Provinces. This species has hitherto only been known with certainty from Assam.

(*b*) The discovery of an *Arundinella* (vern. *tadhodia*) by Mr. T. Carr, Divisional Forest Officer, Haldwani, which, although allied to the ordinary Indian form of *A. brasiliensis* Raddi (vern. *phurkia*), differs from it considerably and is possibly a distinct species. Further specimens have been asked for with the object of cultivating the grass at Dehra.

(*c*) Aromatic specimens of *Andropogon intermedius* Br. sent by Mr. J. Whitehead, Divisional Forest Officer, Gorakhpur, United Provinces, showed that there is practically no character to separate this species from *A. odoratus* Lisboa, except only that glume I of the latter is pubescent. It is probable that the latter is merely a variety of the former.

(*d*) The discovery of *Cymbopogon Schœnanthus* Spreng. in Goalpara, Assam, by Mr. Atulananda Dass, Extra Assistant Conservator of Forests. This species has hitherto not been reported east of the Punjab.

(*e*) The discovery by Mr. Witt, Deputy Conservator of Forests, Central Provinces, of an *Iseilema* allied to *I. laxum* Hack. but possibly distinct. The grass has been sown at Dehra and will be described in detail if it proves sufficiently distinct.

Systematic work. Xylia.—Through the kindness of local forest officers, a number of specimens of *Xylia* were received during the year from Burma and India. A preliminary examination of this material revealed the remarkable fact that, whereas all the specimens from Burma (Katha, Pyinmana, Toungoo, Zigon, Henzada and Ataran Divisions) showed no glands upon the anthers, all the specimens from India (from North Thana and North Kanara in Bombay, from South Malabar in Madras and from Balaghat and Bhandara in the Central Provinces showed a large and perfectly distinct stipitate gland on the anthers. It appears probable, therefore, that the Indian tree will have to be distinguished as *Xylia xylocarpa* Roxb. while the Burmese pyinkado will stand as *Xylia dolabriformis* Benth. Further study, however, is necessary to settle this and other points. A paper detailing the results obtained to date and indicating what specimens are still required for the adequate description of the Indian and Burmese forms of this genus was contributed to the *Indian Forester* at the close of the year.

Grewia.—The study of this genus was continued but, not being of first-class importance, had frequently to give way to more important work during the year. It is hoped, however, that publication will be

completed next year. There is probably only one other known genus (*viz.*, *Eucalyptus*) in which similar complications are met with on account of the occurrence of adventitious shoots and in *Grewia* the complications are increased by the fact that such twigs commonly bear, not only leaves, but also flowers and fruit which often differ widely from those of normal twigs. Consequently it is impossible to work on sound lines unless it is known whether the material dealt with is adventitious or not. The patient collection and study of suitable material in this case, therefore, requires much time and unusual labour.

Identification and local forest floras.—The collection of material for the study of the genera *Saccharum Cinnamomum* and *Anogeissus* was continued as far as possible. Seeds of the various forms of Babul, *Acacia arabica*, were obtained and sown at Dehra for the purpose of testing their constancy. Owing to the fact that local forest officers are frequently ignorant of the names of the species which occur in their forests, it is at present very difficult, or impossible, to obtain accurate information regarding the distribution of species of economic importance or to calculate the yield available in different localities of the economic products yielded by them. The creation and extension of industries depending on these products is consequently delayed and hampered. The preparation of local Floras and Lists which would enable any one of average ability to quickly identify the important species found in his forests is therefore a work of considerable economic importance. Owing to the necessity of encouraging this work and to the fact that the Botanical Library and Herbarium at Dehra Dun have now become fairly efficient, it was decided during the year that the Botanist ought to undertake the identification of specimens for Forest Officers, as a part of his regular duties. Owing to the fact that the Botanist has no Assistant and is obliged to do this work himself, it is clear that it can be carried out only on a small scale at present, as otherwise the progress of research work would be seriously hampered. During the year under report, however, the Botanist identified 246 specimens, whereas in previous years the total number of specimens identified has not exceeded 50.

New species.—Incidentally this work has resulted in the discovery of a new species of *Albizzia* from the Tinnevelly district of Madras. This was found by Mr. H. A. Latham, Deputy Conservator of Forests, and a full description of the same under the name of *Albizzia Lathamii* was sent to press during the year. A *Terminalia* new to Burma has been received from Tavoy, a description of which will shortly be published,

and a *Litsæa* from the Tista Division of Bengal which will also probably prove to be new.

Exotics.—A considerable amount of time and money has been spent in the past by Forest Officers in India on the cultivation of exotics. In order to realise the maximum benefit from the work which has been done, it is proposed to systematically collect and publish all the information available regarding those exotics which distinctly promise to be of forest importance in India, with notes on the conditions under which they have been found to thrive and their economic uses. A paper on this subject dealing with *Prosopis juliflora* DC. was sent to press during the year. Future publications will deal with *Eucalyptus* species and others. It is also hoped that, in future, it will be possible to arrange for more precise information, than has usually been available in the past, regarding valuable exotics and the conditions most likely to suit them, from foreign correspondents to whom seeds of our indigenous species are supplied.

Tree diseases. Spike-disease of Sandal. Trametes Pini.—Arrangements were made at the close of the year for the collection of all the available literature and information regarding the spike-disease of Sandal, the study of which will be commenced by the Botanist in Coorg next year. The results of the preliminary investigation regarding the attack of *Trametes Pini* on *Pinus excelsa* in the Punjab will it is hoped be issued early next year.

6. In addition to the specimens noticed in the above report many were collected as usual by local officers and sent to the Imperial Mycologist, Pusa, Calcutta Botanical Gardens, Reporter on Economic Products to Government of India, and others. The formation of a local forest herbarium was commenced by the Chief Conservator of Forests, Burma, during the year and collections for the local forest herbarium, Sind Circle, were continued. Mr. A. Rodger continued his work on the preparation of a list of species for the Ruby Mines Division. Mr. D. O. Witt published his illustrated list of the grasses of the Berar Circle, Mr. W. A. Talbot published the second volume of his *Forest Flora of Bombay* and Mr. Rama Rao an account of the host plants of the Sandal tree. Further details are given under the Botanical Survey and Mycology sections of the report.

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BOTANY.

III.—MYCOLOGY.

BY

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I.—Plant Pathology.

The work of the Mycological Section at Pusa, which was completed during the year, includes investigations on sugarcane diseases, *Rhizoctonia* and *Phytophthora Colocasiæ*.

The chief diseases of sugarcane investigated were red-rot and an undescribed disease caused by a species of *Cephalosporium*, which presents many points of resemblance to red-rot and is frequently confused with it. The actual channels by which the parasites gain entrance to the cane have been determined by a large series of inoculation experiments. It is hoped that the result of the work, an account of which is being prepared for publication, will be to improve the methods by which serious injury from these diseases may be prevented.

Mr. Shaw, Supernumerary Mycologist, has in the press an account of his researches during the past two years into the morphology and parasitism of *Rhizoctonia*, a soil-dwelling parasite with a wide range of victims. Jute, cotton, ground-nut, cowpea, potato and sesame are amongst the plants attacked. Two species are distinguished, *R. Solani* Kühn, of which the perfect fruiting stage is not yet certainly known, and a species with larger sclerotia, of which the fruiting stage is the Basidiomycete, *Corticium vagum* B. & C. For the last, the old name *R. violacea* Tul., ordinarily used to cover both forms, is proposed to be retained. The beginnings of the formation of specialised races on individual hosts can be observed in *R. Solani*, as the race on jute cannot infect cotton, ground-nut or cowpea, while the forms on these last three hosts can pass freely from one to another. No cereal crop has, so far, proved susceptible to the attacks of these parasites and in a proper attention to rotation probably lies the best means of lessening their ravages.

A disease of the country vegetable, *Colocasia antiquorum*, caused by *Phytophthora Colocasiæ* Rac., has been under study by the writer for some time past. The fungus was obtained in pure culture last year and this has permitted of rapid completion of the investigation, the

results of which will be published shortly. The disease resembles in many respects the well-known potato blight caused by *Phytophthora infestans*, especially in persisting from year to year in the tubers and in only forming a true sexual stage in artificial culture. A second species of *Phytophthora*, on castor, is being studied by Mr. J. F. Dastur, First Assistant, and these two researches have added considerably to our knowledge of the genus.

Mr. Burns has published the concluding account of his three years' experiments in the treatment of grape-vine mildew (*Oidium*) in the Bombay Presidency. The results are considered to demonstrate conclusively the usefulness of the treatment. The spray used was Bordeaux mixture of the 6-4-50 formula (6 lbs. copper sulphate, 4 lbs. freshly burnt quicklime and 50 gallons water) to which was added soft soap at the rate of 5 lbs. The latter was intended to make the spray effective against insects and to increase its adhesiveness. Five sprayings are recommended, one about the middle of May, a second about the middle of August, a third about the middle of October, a fourth about the beginning of December and a fifth about the beginning of January. The last two should be at half strength of the mixture. The result of the treatment has been to reduce the number of attacked bunches from 100 to 21 per cent. and of attacked fruits per bunch from 22 to 1 per cent. The cost is estimated as Rs. 22 initial (cost of sprayer, etc.) and about Rs. 40 per acre annual (cost of materials).

Mr. Anstead has published a detailed account of the work done in Southern India in checking " pink " disease of Hevea rubber, caused by *Corticium salmonicolor* B. & Br. He recommends cutting out the affected parts, where the disease has already appeared, and painting the trees with Bordeaux mixture in May or June as a preventive. The formula recommended is 4-4-45 and resin is added to aid the mixture to stick to the trees. The cost is about a pie per tree or not more than Rs. 2 per acre. The results have been very encouraging and experiments are being continued to perfect the methods.

The writer described two diseases of wild vines, one of which is also known to attack the cultivated species. Neither of these diseases occurs in Europe, where, if introduced, they might become serious pests. Both are caused by rust fungi of unusual types.

Mr. Ajrekar has submitted for publication a note on the rust of Castor (*Melampsorella Ricini*). This fungus is known only in the uredo stage. None of the varieties of castor ordinarily grown in Bombay is

immune. The disease is severe in the southern part of the Presidency only.

Mr. G. S. Kulkarni has given a preliminary account of the red-rot of sugarcane in Bombay, in a paper in which the characters of the disease are described, the methods of treatment indicated and a number of interesting field observations recorded. He has also, in conjunction with Mr. Ajrekar, commenced experiments with a view to checking the *Koleroga* of betelnut in North Kanara, where it is responsible for damage estimated at nine lakhs of rupees annually. Further work on the prevention of the same disease, in continuation of that reported last year, was carried out by Dr. Coleman, who issued a vernacular leaflet on the subject.

II.—Systematic Mycology.

Two parts of the descriptive list of Indian fungi, which is being issued by Messrs. H. & P. Sydow in conjunction with the writer, were published during the year. These included the *Ascomycetes* and *Exobasidiaceæ* of the Pusa Herbarium, together with additions to the lists of *Phycomycetes*, rusts and smuts previously published. The total number of additional species recorded was 316, distributed in 108 genera, of which 1 genus and 115 species were new to science. A large proportion of the remainder consisted of species new for the Indian flora. Of the new species the majority (72) were *Ascomycetes*, a group which has received little attention in India, 26 were rusts, 11 smuts, 2 *Phycomycetes* and 4 *Exobasidia*.

The writer described a remarkable aquatic fungus found at Pusa and Poona, assigning to it a position in the family *Leptomitaceæ*. It is an aberrant member of the family, inasmuch as it has a completely segmented thallus. Reasons are given for considering the *Leptomitaceæ* to be a more primitive group than is usually admitted, and for holding them to be derived, through forms resembling *Monoblepharis*, from the *Siphoneæ* amongst the green Algæ.

Mr. Ajrekar has worked out the life-history of *Cystopsora Oleæ* Butl. This rust consists of æcidial and teleuto stages only, the uredo being omitted. The whole life-cycle is passed on the one host, *Olea dioica*.

Mr. Kulkarni has discovered the conidial stage of the *Sclerospora* which is parasitic on jowar and considers that it presents sufficient differences from this stage of *Sclerospora graminicola* to warrant its separation as a distinct species.

List of Publications.

AJREKAR, S. L. . A note on the Life-history of *Cystopsora Oleæ* Butl. (*Annales Mycologici, x, p. 307, 1912.*)

ANSTEAD, R. . . Bordeaux mixture and Pink disease of Hevea rubber. (*United Planters' Association of Southern India, Bull. No. 1, 1912.*)

BURNS, W. . . Second year's experiments in the treatment of Grape-vine mildew in the Bombay Presidency. (*Dept. of Agric., Bombay, Bull. No. 45, 1911.*)

,, Third year's experiments in the treatment of Grape-vine mildew in the Bombay Presidency. (*Dept. of Agric., Bombay, Bull. No. 51, 1912.*)

BUTLER, E. J. . . On Allomyces, a new aquatic fungus. (*Annals of Botany, xxv, p. 1023, 1911.*)

,, The rusts of wild vines in India. (*Annales Mycologici, x, p. 153, 1912.*)

KULKARNI, G. S. . Preliminary study of the red-rot of sugarcane in the Bombay Presidency. (*Dept. of Agric., Bombay, Bull. No. 44, 1911.*)

SYDOW, H. & P., & BUTLER, E. J. Fungi Indiæ Orientalis, Parts III and IV. (*Annales Mycologici, ix, p. 372, 1911, and x, p. 243, 1912.*)

BOTANY.

IV.—AGRICULTURAL BACTERIOLOGY.

BY

C. M. HUTCHINSON, B.A.,

Imperial Agricultural Bacteriologist.

Soil Bacteriology.—The work of the Bacteriological Section at Pusa during the year has been mainly directed towards ascertaining what factors determine biologic activity in Indian soils, and to the measurement of the changes resulting therefrom under various conditions. The main problem so far dealt with has been the supply of available nitrogen as provided by the biolysis of such substances as green manures, root residues, and organic manures. No work has been done upon nitrogen assimilation by Legume bacteria or such organisms as Azotobacter, Clostridium, or Rhizobium.

The method of determining the biologic activity of a soil by plate counts has been abandoned in favour of methods depending upon measurement of the physiological activity of the soil organisms. By the use of such methods biological analyses of soils may be carried out which will provide indications as to their relative capabilities for dealing successfully with organic manures. Far more valuable information, however, is also obtained by such analyses. By the use of fairly large portions of soil, it is perfectly feasible to set up and maintain conditions of moisture and æration comparable with those in the field, and to determine in the laboratory for any particular soil under what conditions of water supply, tillage, and addition of lime or manures either natural or artificial the greatest amount of ammonification and nitrification will result.

It has been ascertained by numerous experiments that the rate of formation of carbon dioxide in a soil is directly proportional to the biologic activity of that soil, and that conditions unfavourable to the latter will also adversely influence the former. A simple method of measuring the rate of formation of carbon dioxide in soils under various conditions has been devised and by this means it is possible to determine what moisture content of any particular soil is the optimum for bacterial activity; this has been found to vary from as high as 37 per cent. in one case to as low as 16 per cent. in another. By the same method, the effect of the addition of various manures, organic or mineral, may be observed, and it

has been found possible in this way to prescribe the addition of certain substances, such as lime or superphosphate, to a soil in order to promote the decomposition of green manures, oil cake, or cattle manure buried in it. Similarly by determining the optimum moisture content, recommendations can be made as to variations in field practice which would tend to dry out the soil in one case or to conserve moisture in another; a very large number of observations have been made as to the conditions under which ammonification and nitrification take place in Indian soils. It has been found that important differences exist between the biological changes taking place in the latter and those which have been observed in the soils of Europe; these differences appear to be due to the high average temperatures of Indian soils and their consequently high relative rate of bacterial action. In soil at temperatures between 15° C. and 18° C. the process of ammonification, which is the natural and necessary predecessor of nitrification, takes place at such a rate as to allow the latter to proceed *pari passu;* in many Indian soils, however, it has been found that at the higher temperatures, 25° C. to 30° C. which obtain in them for many months in the year, ammonification may proceed with such rapidity as to produce a concentration of ammonia in the soil water sufficiently high to interfere with nitrification or even to inhibit it altogether. Where large quantities of nitrogenous organic matter are turned into the soil and put under intensive cultivation much nitrogen may be lost in the form of ammonia, and experiments have shewn that biolysis of organic nitrogenous material requires very careful investigation from this point of view.

In particular, it has been found that temperature plays an important part in deciding whether ammonification will proceed at such a rate as to allow of concurrent nitrification; thus organic nitrogenous matter in soil at a temperature of 20—22° C. may be completely nitrified, whereas at 28—30° C. large quantities of nitrogen are lost as ammonia. It is evident that this fact must be taken into account in selecting the time of year for applying organic manures, along with other considerations depending on local meteorological conditions and the optimum moisture content of the soil.

Further experiments have demonstrated another source of loss of nitrate nitrogen. It has been shewn that where intense bacterial action is taking place in soil any nitrates present may be reduced without the occurrence of anærobic conditions; it appears probable that the nitrate is utilized as a source of nitrogen by the bacteria. It was found, for instance, that in Pusa soil the optimum moisture content for nitrification

is 16 per cent., whereas general bacterial action is intense up to 25 per cent. and at the latter figure rapid reversion of nitrate to the proteid form takes place. This would help to explain observations made in field practice both at Pusa and in the Punjab, that excess of soil moisture produces nitrogen starvation of the wheat crop; the importance of biological analysis of irrigated soils by such methods will readily be realized.

A special enquiry has been carried on and is still proceeding, to determine the conditions under which bacterio-toxins are formed in soils and their effect in inhibiting bacterial action. The work of Greig Smith of N. S. Wales on this subject has demonstrated its importance, and experiments at Pusa have fully confirmed his views. Mr. Meggitt, Agricultural Chemist, Eastern Bengal and Assam, has carried out a series of investigations on similar lines, but the enquiry is not sufficiently complete for detailed report.

An investigation as to bacterial action in rice soils was carried out at Coimbatore by the Agricultural Chemist to the Government of Madras. It was found that in puddled soil the anærobic conditions prevailing prevented the formation of nitrate, confirming the conclusions of previous workers that the rice plant obtains its nitrogen in the form of ammonia; further experiments in the field showed that for the same reason the use of nitrate of soda or of potash as a paddy manure, resulted in loss of nitrogen by denitrification.

Plant Pathology.—A bacterial disease of tobacco at Rangpur was investigated and found to be due to an infection of *B. Solanacearum*. The strain isolated was found to be also pathogenic to *Solanum Melongena*, Tomato, *Datura*, and Potato. The incidence of the disease at Rangpur and Burirhat was not apparently associated with any insect attack or specially unfavourable soil conditions, and was not heavy enough to cause apprehension as to future spread. The parasitism of the causative organism as isolated from diseased plants in the field was found to be insufficiently strong to attack healthy plants, although by passage through several individuals or by artificial culture on Potato it could be raised to a high degree of virulence. For this reason the practice of leaving the plants in the ground for a second cutting should be avoided in infected areas.

B. Solanacearum was also found attacking potatoes by Coleman in Mysore.

A bacterial disease of wheat in the Punjab locally known as "Tannan" or "Tandu" was investigated; this was found to be due

to the attack of a bacillus closely resembling *Ps. Hyacinthi* which invests the opening ear with a sticky growth causing deformation and stunting and preventing ripening of the grain. The attack is confined to small badly drained areas and can probably be avoided by proper cultivation; its distribution is limited and it is probably of no economic importance.

Disease of Eri Silkworms.—A disease of eri worms resembling "flacherie" was found to be associated with the presence of bacteria in the intestine. Investigation showed that the immediate cause of disease was improper dieting leading to indigestion; this was aggravated by a thickening of the peritrophic membrane due to invasion of the latter by bacteria, and resulting in impairment of digestion by suppression of secretion of the digestive fluids.

Experimental infection with cultures of bacteria isolated from the intestine did not produce results sufficiently conclusive to warrant the assumption that these bacteria were an immediate cause of the disease. Enquiries made in various districts in Assam where the disease is well known, confirmed the conclusion that improper diet is its immediate cause.

List of Publications.

HUTCHINSON, C. M. . Studies in Soil Bacteriology. No. 1. (*Mem. Dept. of Agriculture in India, Bacteriological Series, No. 1, 1911-12.*)

,, ,, Rangpur Tobacco Disease. (*Mem. Dept. of Agriculture in India, Bacteriological Series, No. 2.*)

,, ,, A Disease of Eri Silk Worms. (*Mem. Dept. of Agriculture in India, Bacteriological Series, No. 3.*)

,, ,, A Bacterial Disease of Wheat in the Punjab. (*Journ. of Agricultural Science, Vol. V.*)

FORESTRY.

I.—SYLVICULTURE.

BY

R. S. TROUP, F.C.H.,

Sylviculturist.

Statistical work in typical forest crops.—Good progress was made during the year in the collection of statistics by measurements in sample-plots laid out in typical forest crops in the United Provinces, 53 permanently demarcated plots and 43 temporary plots having been laid out and measured. The principal species dealt with were *Shorea robusta, Cedrus Deodara, Pinus excelsa, Pinus longifolia, Quercus incana, Quercus dilatata* and *Quercus semecarpifolia.* The objects of these measurements are the ultimate compilation of yield-tables giving the average rate of development of forest crops, of different types and qualities, in girth, height and volume, and the determination of the frequency and intensity of thinnings which will produce the maximum volume increment per acre per annum. The want of such statistics has rendered it impossible hitherto to ascertain the most profitable rotations on which to work forest crops of different kinds in India: without some accurate forecast of the kind there is no alternative but to go by guess work, a proceeding which may involve heavy financial loss. The value of accurate statistical work is well recognised in European forestry, the result being the highest possible return on the forest capital and a maximum net annual yield per acre. Although the general application in India of all the scientific methods known to economic forestry in Europe is at present out of the question, there are nevertheless many types of forest where these principles could be applied, and the extension of statistical work, with this end in view, is greatly to be desired. This work is, so far as present conditions admit, now almost completed in the United Provinces, and it is proposed to extend it to other Provinces during the coming season.

The sal tree (Shorea robusta).—The sylviculture of the *sál* tree continues to be the subject of special investigation, and various experimental plots in the forest, dealing with the natural reproduction of the tree, are under observation. Some preliminary tests were carried out throughout the principal *sál* tracts of India with a view to ascertaining to what extent the fertility of *sál* seed is influenced by the size, condition and environment of the seedbearers. The results tend to show that neither the size of the trees, nor their degree of soundness,

nor the locality, soil, aspect, and type of forest in which they grow, have any appreciable effect on the fertility of the seed produced by them.

Financial results of plantations.—Ever since its initiation the Forest Department has been engaged in planting operations in various parts of India. Some of these plantations have been formed after due consideration, and with the idea of yielding good financial returns: on the other hand there can be no doubt that much loss has been incurred through haphazard planting operations without sufficiently accurate financial forecasts. There are now sufficient *data* available, with respect to many of the more important plantations of India, for affording means of gauging their financial success or otherwise, and ascertaining the factors contributing towards success or failure. With the co-operation of the Divisional Forest Officers concerned a commencement has been made with this important work, a large number of measurements having been carried out in the Eucalyptus plantations of the Nilgris and in the teak plantations of South Malabar: the statistics collected are under compilation, and will be published when complete.

Teak forests of Burma.—An examination of the statistics contained in all existing working-plans for the natural teak forests of Burma has been made, and the results were published during the year. In the 6,105 square miles of teak-bearing forests dealt with it is a striking fact that the three forests richest in teak trees 3 feet in girth and over are on flat alluvial land, the richest of all being the Mohnyin Reserve in the Katha Division, containing 707 such trees per 100 acres. There are five forests with over 400, and nine with from 300 to 400 such trees per 100 acres. In no case does the average percentage of teak trees 3 feet in girth and over in teak-bearing forests exceed 33 for whole reserves, while in some cases it falls as low as 6; in the Mohnyin Reserve the percentage is probably higher than 33, though the absence of enumerations of species other than teak makes it impossible to substantiate this. In individual sample-plots the enumerations naturally show far greater richness: the plot richest in large sized teak trees, one of 52 acres situated in the Taungnyo Reserve of the Zigôn Division, contained at the time of enumeration no fewer than 689 trees 7 feet in girth and over per 100 acres, while in a plot 20·4 acres in extent in the Mohnyin Reserve 5,560 teak trees 3 feet in girth and over were enumerated.

The beneficial effects of concentrated working on the natural regeneration of teak are strikingly exhibited by the enumerations in the Pegu Yoma forests of the Pyinmana Division, Upper Burma. These forests

were heavily overworked before the British occupation, and the percentage of large trees is small; aided, however, by the openings made in the overwood, the constant breaking down of bamboos by working elephants and the wounding of the soil during extraction, natural regeneration of teak has sprung up in great profusion, the figures showing that in the eight reserves in question in no case does the crop of young trees under 3 feet in girth average less than 768 plants per 100 acres, a result attained in only two other reserves in Burma.

In true teak-bearing forest of the recognised types the average rate of growth is found to be fastest in alluvial forest of the "lower mixed" type and slowest in dry "upper mixed" forest, an average tree 7 feet in girth varying in age from 110 to 190 years. The fastest and slowest rates of growth recorded for individual trees are ages of 42 years and 357 years for trees 7 feet in girth, representing mean annual girth increments of 2·00 and ·240 inches respectively. The average age of a 7 feet tree throughout the whole of Burma is 155 years: here the mean annual girth increment declines steadily from ·621 inches at an age of 58 years, representing a girth of 3 feet to ·542 inches at an age of 155 years. The actual rotations fixed in working-plans vary from 120 to 200 years, after allowance has been made for the time taken for a seedling to establish itself. So far as the results of actual felling operations under the working-plans are concerned, it is found that only in the richest forests does the average yield of marketable teak trees, spread over a series of years, exceed 10 trees of 7 feet girth and over per square mile per annum (that is, per square mile of total teak-bearing forest, not of forest actually worked over). The highest average yield has been furnished by the Mohnyin forest, which has yielded 24 such trees per square mile per annum. The statistics given above exhibit the comparatively small proportion of teak in the natural forests of Burma, and point to the advisability of increasing that proportion as far as is sylviculturally possible and desirable. Measures likely to effect this object were indicated in the report on Sylviculture for 1909-10.

Developments in Sylvicultural Systems.

(a) Teak (Tectona grandis).—A decided advance in sylvicultural methods in Burma has been made by the application of a modification of the system of successive regeneration fellings to the Mohnyin working circle under Mr. H. R. Blanford's working-plan, issued during the year. This is the first time this system has been substituted for the selection system hitherto universally applied to the Burma teak forests. The forest in question is of somewhat abnormal type, consisting as it does to a great extent of almost pure stretches of large sized teak with

little or no regeneration. Experiments extending over several years have shown that regeneration can be induced in abundance by opening the canopy thoroughly and burning the undergrowth, the young crop resulting from these operations being assisted by repeated weedings. The exploitable girth is fixed at 8 feet, and the rotation corresponding is calculated to be 180 years; this rotation is divided into nine regeneration periods of 20 years each. The fellings will take the form of clear fellings over successive small areas until the whole periodic block has been regenerated: it thus differs from the group system and the usual system of successive regeneration fellings in that only one felling, and not a succession of fellings, will be carried out over any given patch dealt with.

(b) Deodar (Cedrus Deodara).—Forest Officers in the Punjab have for some time past been confronted with the fact that the selection system has by no means proved a satisfactory one for the working of deodar forests, since this species, from its habit of regenerating freely, and in masses, only if the overwood is drastically opened out, is better adapted for regeneration under the group system than under the selection system. The application of the group system to deodar forests was the subject of discussion at a recent Forest Conference at Lahore: as a result of the discussion it was resolved to await the experience derived from carrying out the prescriptions of recently framed working-plans dealing with that system, before deciding on further details regarding its application.

Mr. C. G. Trevor's working-plan for the Upper Ravi Forests, Chamba State, prescribes the working of deodar under the group system: the rotation is fixed at 140 years, divided into five regeneration periods of 28 years each. The number of successive fellings has been provisionally fixed at four for the period, the interval between them being 7 years.

(c) Blue pine (Pinus excelsa).—The same working-plan prescribes the working of blue pine under the group system; the rotation is fixed at 100 years, divided into four regeneration periods of 25 years each. Three successive fellings are considered sufficient to effect regeneration.

List of Indian Publications, 1911-12.

BLANFORD, H. R. . Working-plan for the Mohnyin and Bilumyo Reserved Forests, Katha Division, Upper Burma.

CHANNER, F. F. R.	Working-plan for the Terai and Bhabar Government Estates Protected Forests, United Provinces.
HOPWOOD, S. F.	Working-plan for the Ahlaw Working Circle, Upper Chindwin Division, Upper Burma.
MAITLAND-KIRWAN, J. D.	The Coppicing Powers of *Babul* (*Acacia arabica*). (*Ind. For., xxxvii, 430.*)
OSMASTON, A. E.	Experiments on Coppicing *Sál* in the Gorakhpur Forest Division, Eastern Circle, United Provinces. (*Ind. For., xxxvii, 434.*)
STEVENS, E. R.	The Uniform System for *Sál* Forest. (*Ind. For., xxxvii, 605.*)
TRAFFORD, F.	Working-plan for the Forests of the Sundarbans Division, Bengal.
TREVOR, C. G.	Working-plan for the Upper Ravi Forests, Chamba State, Punjab.
TROUP, R. S.	A Manual of Forest Mensuration.
,, ,,	A Note on some Statistical and other Information regarding the Teak Forests of Burma. (*Ind. For. Rec., iii, Pt. I.*)
,, ,,	A Glossary of Technical Terms for Use in Indian Forestry—*revised edition.* (*For. Bull., No. 4, 1911.*)
,, ,,	A Note on some Germination Tests with *Sál* Seed (*Shorea robusta*). (*For. Bull., No. 8, 1912.*)
,, ,,	The Calculation of the Yield by Number of Trees under the Selection System. (*Ind. For., xxxviii, 75.*)
,, ,,	Working-plan for the Thano Forest, Siwalik Division, United Provinces.

FORESTRY.

II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, F.L.S.,

Forest Economist.

1. **Technical properties of *sal* timber.**—Specimens of hill and plains-grown *sál*, of seedling and coppice origin, obtained from the United and Central Provinces were sent to Sibpur to be tested. The results obtained so far are not conclusive, so that further specimens are being sent in order to obtain definite results as to the transverse strength and resistance to crushing and shearing of the various varieties of *sál* timber.

Sál logs of the above-mentioned varieties were laid down to season under different conditions, and the percentage of moisture in the timber was recorded. They will be inspected from year to year until completely seasoned. At the time when these experiments were commenced, and before the logs were laid down to season, specimens were cut from them to determine the specific gravity of the timber when green and after it had seasoned, and also with which to carry out splitting tests. The splitting tests with green timber were carried out during the year, those on dry timber will be carried out when the timber is thoroughly seasoned.

2. **Outturn, uses, durability and prices of *sal* timber.**—Figures of outturn of *sál* from Government and Private forests were collected during the year and also data as to the average annual number of *sál* sleepers purchased by the various railway systems of India. The Public Works Department officials and others furnished most detailed information on the uses and durability of *sál* timber when used in the open, under cover, in water and when buried in the ground, while the Railway officials furnished details as to the durability of *sál* sleepers, and their resistance to the cutting action of the rail and as to the tendency of the spike to shake loose. Information has also been collected regarding the past and present prices of *sál* timber and sleepers.

3. **Minor products obtained from the *sal* tree.**—The necessary information for a complete Note on the Minor Products obtained from *Shorea robusta* was collected, such as outturn and prices of *sál*

damar, the bark in connection with tanning, and the use of the fibre and leaves.

4. **The match industry.**—The Economist visited several districts in Oudh and after carrying out enumerations, reported on the available supply of suitable timber for match making. The amount available was found to be sufficient to work one or more match factories. Samples of timber from the Sunderbans and Madras were sent to an expert to be tested, and in several instances were found to be most suitable for match-making.

5. **Bamboo paper-pulp.**—This enquiry, which has been in progress for nearly three years, is now practically completed. Many bamboo areas have been inspected on the West Coast in Bombay and Madras, in Burma and Arakan. During the year a further area was inspected by the Economist in Cachar, large quantities of bamboo of different species have been converted into pulp on a commercial scale, and it has been found possible to make a good quality of paper within a working limit of cost.

6. **Antiseptic treatment of woods.**—(*i*) The experimental powellized sleepers, numbering 2,929 in all, have been handed over to the North-Western, Oudh and Rohilkhand and the Eastern Bengal State Railways, and laid down on the lines in order to note their behaviour. The above number of sleepers was made up of 860 *Terminalia tomentosa*, 435 *Dipterocarpus tuberculatus*, 121 *Dipterocarpus alatus*, 704 *Pinus excelsa* and 809 *Pinus longifolia*.

(*ii*) Another experiment has been carried out by treating 2,000 sleepers of the above-mentioned species with *Avenarius Carbolineum* oil. The two species of pine sleepers which were treated by the Economist have been handed over to the North-Western Railway, those treated in Bombay and Burma will be handed over to the Railway authorities in the near future.

(*iii*) An experiment to treat a third set of sleepers by a mixed impregnation method is now in hand.

7. **Tea-boxes.**—The Economist toured in several districts of Assam in order to ascertain the difficulties under which the tea-box industry is carried on in that province. The chief difficulties are the want of accessible timber and the liability of the timber to the attack of insects. Experiments to protect the timber were carried out during the year.

8. **Gums and resins.**—Experiments were carried out to ascertain the best method of tapping *Boswellia serrata*, with indifferent results. It was thought that the hot weather was not a suitable season in which

to carry out tapping operations, so that it is proposed to carry out further experiments during the cold weather of 1912-13.

Many enquiries were received from Europe on the Burmese wood-oil of *Melanorrhœa usitata* and information collected as to the local uses and method of preparing the varnish in Burma.

9. **Miscellaneous uses of woods.**—Samples have been supplied to, and experimented with, by makers of matches, pencils, tool-handles, weaving looms, cement barrels, wood veneers, musical instruments, packing cases, etc., while specimens of canes were sent to a firm and found suitable for cricket-bat handles.

10. **Tan barks.**—Figures of outturn and cost f. o. r. of seven species of tan barks were collected from the various provinces. After ascertaining that one or more of these barks are available in large quantities and at reasonable rates, it is proposed to prepare fair-sized samples of tan extracts for valuation.

11. **Economic and wood museums.**—A large number of specimens were collected for both museums, especially wood specimens. A complete collection of teak specimens from all parts of India and Burma was commenced, the number collected so far being 79. It has not been found possible to arrange the fine collection of timber and minor products received from the Allahabad Exhibition, all that it is possible to do is to house the specimens until the new Research buildings have been erected.

12. **Botanical and other specimens.**—A number of botanical and other forest product specimens were supplied by the Forest Department to various Government Departments, private persons, firms and institutions in India, England, Germany and Australia.

List of Publications.

BATEMAN, E. . . A visual method for determining the penetration of inorganic salts in treated wood. (*U. S. Dept. of Agr. Cir. No. 190.*)

BOND, FRANCIS M. . Progress Report on wood-paving experiments in Minneapolis. (*U. S. Dept. of Agr. Cir. No. 194.*)

BRAND, C. J. . . Crop Plants for Paper-making. (*U. S. Dept. of Agri. Cir. No. 82.*)

CLINE, MCGARNEY . Strength values for structural timbers. (*U. S. Dept. of Agri. Cir. No. 189.*)

PEARSON, R. S. . . Note on the Antiseptic Treatment of timber in India with special reference to railway sleepers. (*Ind. For. Rec., Vol. III, Part II.*)

PEARSON, R. S. . . Commercial Guide to the Forest Economic Products of India.

PURAN SINGH . . Note on the Preparation of Tannin Extracts. (*Ind. For. Rec., Vol. III, Part IV.*)

PURAN SINGH . . Method of distinguishing the powellized and the unpowellized wood. (*Ind. For., October 1911, p. 567.*)

PURAN SINGH . . *Podophyllum Emodi.* (*Ind. For., April 1912, p. 156.*)

RAITT, W. . . Report on the Investigation of Bamboo as Material for Production of Paper-pulp. (*Ind. For. Rec., Vol. III, Part III.*)

TEESDALE, C. H. . Volatilization of various fractions of Creosote after their injection into wood. (*U. S. Dept. of Agr. Cir. No. 188.*)

VINCENT, HARRY . Bamboo-pulp as the paper material of the future. (*Ind. For., November 1911, p. 627.*)

WOOLSEY, THEODORE S. Turpentining in Florida on an American National Forest. (*Ind. For., June 1912, p. 280.*)

ZOOLOGY.

I.—ZOOLOGICAL SURVEY.

BY

STANLEY KEMP, B.A.,

Officiating Superintendent, Indian Museum.

As explained in the introduction to last year's report, this brief account of the zoological research undertaken during the year is drawn up with special reference to that carried out in the Indian Museum, though, with the exception of that of Departments which themselves submit reports to the Board, other work which has a direct bearing on the Fauna of the Indian Empire is not neglected.

Field work.—Most of the field work effected during the year has been carried out on the lines indicated in last year's report. The survey of the fresh-water fauna of the Indian Empire has been continued and results of considerable value have been obtained; it was in work of this nature that Dr. Annandale interested himself during a month's leave in Ceylon in October 1911.

Dr. Annandale in company with Mr. F. H. Gravely visited Purulia in February and Puri and Cuttack in March; on each occasion extensive collections were made and the latter tour resulted in the discovery of *Caridinicola*, a new and very curious flat-worm of the order *Temnocephaloidea*, living on fresh-water shrimps of the family *Atyidæ*. In April, Mr. F. H. Gravely in company with Mr. S. P. Agharkar, Lecturer on Biology in the Elphinstone College, Bombay, spent three weeks in the Western Ghats and Konkan. This tour, which was undertaken with the object of again finding the fresh-water Medusa, *Limnocnida*, first discovered by Mr. Agharkar during the previous year, proved eminently successful: the Medusa was found in considerable numbers and valuable observations were made on its habits. Mr. B. L. Chaudhuri paid two visits to Chota Nagpur, chiefly with the object of obtaining specimens of fresh-water Chelonia and information regarding them. Considerable collections were made in this and in other groups.

In November 1911, Mr. S. W. Kemp left on deputation to accompany the Abor Expeditionary Force as Zoologist and Anthropologist, taking with him Mr. Hodgart, Museum Collector, as his assistant. About four months were spent in the Abor country and extensive collections were

made during this period. The most interesting animal obtained is *Peripatus*, a primitive arthropod which was not hitherto known to exist within the limits of the Indian Empire. The zoological results of this expedition are being published in a separate volume of the "Records of the Indian Museum" and it is believed that among them material will be found which will add very considerably to our knowledge of the inter-relationships of the faunas of the various regions of N. E. India.

On previous military expeditions where any biological work, other than of a private character, has been accomplished, it has been effected by a "Surgeon-Naturalist." This is the first time that a separate officer has been deputed for the purpose and it is hoped that the results obtained will be held to justify the deputation of an officer of the Museum on any similar occasion that may arise.

In November and December 1911, Mr. F. H. Gravely visited Tennasserim passing across the Amherst district to the Burmo-Siamese frontier. This tour was principally undertaken in order to obtain information regarding certain *Arachnida* and *Coleoptera* of this little known region: in this respect the results proved most successful and large collections in other groups were also made. The results of this expedition will, wherever possible, be incorporated with those obtained in the Abor country. The existence of a strong Burmese element in the latter region cannot be doubted and additional information regarding the fauna of Tennasserim will certainly have great interest from a comparative point of view.

It is unfortunate that Captain R. B. Seymour Sewell, I.M.S., Surgeon-Naturalist to the Marine Survey, was recalled to Calcutta two months after the survey season had commenced. During the period when he was on board the 'Investigator' he was employed in continuing his observations on the floating fauna and his introduction of a tow-net of exceptionally large size for obtaining extensive samples of plankton from any depth has produced results of a most satisfactory nature. There can be little doubt, however, that if funds were available for the purpose, the provision of some of the specially designed apparatus now used in this type of research in home waters would render the work still more efficient. No officer was appointed to act for Captain Sewell during the remaining five months of the survey season, but seven trawls were made in deep water producing results of considerable interest.

Mr. C. A. Paiva, late Entomological Assistant in the Museum, spent several months in the Almora district, where he made collections of

insects. The loss of this officer's services is seriously felt in the Entomological sub-section.

As in previous years we are under considerable obligation to a number of private collectors, thanks to whose energy a large number of specimens have been acquired for the Museum. His Excellency Lord Carmichael, Governor of Bengal, is taking great interest in the work of the Zoological Section and arrangements have been made for the sorting and, as far as possible, the identification in the Museum of the large collections which he is making in the Darjiling district. It is already evident that his offer to present specimens of any species not hitherto represented in the Museum is a most valuable one.

Laboratory work.—During the past four months of the year under review the greater part of the time of the officers belonging to the Zoological Section has been spent in the transference of the reserve collections and library to their new quarters. This work, though laborious, has not been entirely unproductive for it has been found possible in the course of the transference to give more space for the accommodation of the collections and to rearrange the majority of them according to a uniform scheme and thus facilitate in a very great degree their accessibility to students engaged in research. The increase in laboratory accommodation has proved a great benefit, but it is already evident that this increase is none too great for our requirements. At the moment the four spare laboratories which are available are occupied by the Professor of Biology at the Medical College, the Deputy Director of Fisheries, Bengal, the Surgeon-Naturalist to the Marine Survey and by Major A. C. MacGilchrist, I.M.S., officer on special duty in connection with the *Stegomyia* Survey, Port of Calcutta.

A considerable amount of work has already been done in the determination of the collections from the Abor country and it is satisfactory to be able to record that quite a substantial number of groups are being dealt with by specialists in India. As far as work within the Museum is concerned, Dr. Annandale completed exhaustive reports on the *Reptilia* and *Batrachia* prior to going on leave and Mr. Gravely, who has finished his account of the *Scolopendridæ*, is now undertaking the examination of certain other groups with which he is acquainted. The identification of the fish, which has been entrusted to Mr. Chaudhuri, is far advanced, and Mr. E. Brunetti has completed a lengthy report on the *Diptera*. Mr. Kemp's paper on the *Crustacea Decapoda* is almost ready for the press. Mr. E. A. Andrews has determined a considerable part of the large collection of *Hemiptera*, and Mr. C. A. Paiva has identified the *Anthophila*,

Several important papers dealing with the fresh-water fauna of the Indian Empire have been published during the year while others are in course of preparation. Dr. Annandale has completed two papers on the aquatic *Chelonia* and has described the fresh-water *Medusa* from the Western Ghats. Mr. Chaudhuri has continued his studies of Indian fresh-water fish; he has published a paper on the species of sting-rays inhabiting the middle and upper Ganges, their range and breeding habits, and has finished an account of new species of fish from Northern India. Mr. Kemp has published a few short papers on fresh-water Crustacea and done some preliminary work on the Indian fresh-water shrimps of the families *Palæmonidæ* and *Atyidæ*. Of other papers which have appeared during the year or are in preparation special interest attaches to the series which Dr. Annandale has named Fauna Symbiotica Indica, which deals with the taxonomy and more particularly the bionomics of Indian animals found living together in a manner which implies something more than fortuitous occurrence, and to his notes on the fauna of the Parésnath Hills. Mr. Kemp's memoir on the group *Stomatopoda* is now in the press and that by Mr. Gravely on the *Passalid Coleoptera* is almost completed. Mr. Gravely is continuing his work on the Indian *Pedipalpi*.

Captain R. B. Seymour Sewell, who in December was appointed Acting Professor of Biology in the Medical College, has continued his studies on *Copepoda* and a report which, in addition to the taxonomy of the group, comprises some most interesting observations on growth stages and development is now in the press. In collaboration with Mr. B. L. Chaudhuri, Captain Sewell has published a semi-popular brochure on certain fresh-water fish which eat mosquito-larvæ. The importance of this subject from the point of view of public health need not be emphasized.

Mr. E. Brunetti, continuing his fruitful work on *Diptera*, has now completed his volume in the "Fauna of India" series on the *Nemocera* other than *Culicidæ*, *Chironomidæ* and *Cecidomyidæ*. Among the papers which he has recently published special reference must be made to his Revision of Oriental Tipulidæ and to his Supplement to the Catalogue of Oriental Mosquitoes. The descriptions of hitherto unknown species which he has completed during the year under review (both published and in manuscript) amount to over 400.

Captain T. L. Bomford, I.M.S., Acting Surgeon-Naturalist to the Marine Survey, has been occupied since his arrival in Calcutta in the identification of part of the collections recently made by the R.I.M.S. "Investigator."

Mr. T. Southwell, Deputy Director of Fisheries, who is now engaged in reorganising the fishery departments of Bengal and of Bihar and Orissa is in occupation of one of the Museum laboratories. Such time as he is able to spare from administrative duties has been devoted to an enquiry into Cestode parasites with special reference to those of fish. It is hoped that arrangements to publish his more purely scientific papers in the "Records of the Indian Museum" will shortly be completed.

Bombay Natural History Society.—The publications of the Bombay Natural History Society have maintained their high standard. The survey of the mammals of India which was inaugurated last year has been prosecuted with vigour as may be seen by reference to the various papers on the subject which have recently been published. It is to be hoped that funds for the continuance of this useful work will be forthcoming. Among the papers of a more popular nature which have appeared in the Society's Journal special reference must be made to Mr. E. C. Stuart Baker's monograph of the game birds of India, Burma and Ceylon and Major F. Wall's treatise on the common Indian snakes. These memoirs are serial in form and both are well illustrated by coloured plates. Work of a more purely scientific nature is not neglected. Important papers such as those of Mr. Rowland E. Turner on Wasps, Mr. E. Meyrick on *Micro-Lepidoptera* and of Sir George Hampson on *Heterocera* will go far to confirm the scientific reputation of the Society at home. As in previous years the Journal abounds in biological notes of great interest.

Other work.—As regards other work which has been accomplished during the year, attention may be drawn to the descriptions of new Cestodes by Mr. J. Hornell of the Government Fishery Bureau, Madras, to the two papers on *Oligochæta* by Major J. Stephenson, I.M.S., Professor of Biology in the Government College, Lahore, and to Captain W. S. Patton's researches on the development of *Herpetomonas donovani* in two species of *Cimex*.

Work done in Europe and America.—During the year Dr. W. W. Fowler's volume in the Fauna of India series has appeared. It comprises a general introduction to the *Coleoptera* and descriptions of the Indian *Cicindelidæ*, *Paussidæ*, *Rhysodidæ* and *Cupedidæ*. The introduction occupies about half the book and, including as it does synoptic tables and a detailed account of all the families of beetles which are known to occur in India, is certain to prove most useful to those engaged on the study of Coleoptera in this country.

Among other works reference to Colonel Alcock's 'Entomology for Medical Officers' must not be omitted. The book deals primarily—and always in the most lucid manner—with those Arthropoda that are known to influence public health. There can be no doubt that it will admirably fulfil the purpose for which it was written, while even the specialist in entomology will find in it much information that he will value.

In the Indian Museum publications the long memoir on Crinoids by Mr. Austen H. Clark is now ready and Prof. Bezzi's monograph of the Dipterous family *Trypetidæ* is approaching completion. Miss Ricardo has published two important papers on *Tabanidæ* and mention may also be made of Prof. Camerano's paper on Gordiid worms and of Mr. Preston's Catalogue of the Naiades in the Indian Museum collection. The latter is a preliminary work undertaken prior to the completion of an account of the fresh-water Mollusca for publication in the "Fauna of India" series.

List of Publications with special reference to Indian Zoology, prepared by B. L. Chaudhuri.

GENERAL.

ANNANDALE, N. . . Notes on the Fauna of Parésnath Hill, Western Bengal. (*Rec. Ind. Mus., vii, 33.*)

,, ,, . . Fauna Symbiotica Indica. (*Ibid., vii, 123, 147 and 243.*)

ANNANDALE, N., & KEMP, S. Observations on the Invertebrate Fauna of the Kumaon Lakes, with special reference to the Sponges and Polyzoa. (*Ibid., vii, 129.*)

HARTLEY, C. . . An exploration of the Beligal-ge, near Balangoda. (*Spolia Zeylan., vii, 197.*)

HICKS, F. C. . Forty years among the Wild Animals of India.

JENKINS, J. T. . . Observations on the shallow water fauna of the Bay of Bengal made on the Bengal Fisheries steam-trawler "Golden Crown," 1908-1909. (*Rec. Ind. Mus., vii, 51.*)

MANDERS, N. . . An investigation into the validity of Mullerian and other forms of Mimicry with special reference to the Islands of Bourbon, Mauritius

and Ceylon. (*Proc. Zoo. Soc., Lond., 1911, 696.*)

PEARSON, J. . . Biological Survey of Trincomalee Harbour. (*Spolia Zeylan., viii, 30.*)

,, ,, . . The growth of Marine Organisms in Colombo Harbour. (*Ibid., viii, 68.*)

STEBBING, E. P. . . Game Sanctuaries and Game Protection in India. (*Proc. Zoo. Soc., Lond., 1912, 23.*)

PROTOZOA.

ANNANDALE, N. . . Occurrence of *Trichodina pediculus* on the manubrium of *Limnocnida indica.* (*Rec. Ind. Mus., vii, 256.*)

PATTON, W. S. . . The development of *Herpetomonas donovani* in *Cimex rotundatus* and in *Cimex lectularius.* (*Sc. Mem., Med. and Sanit. Depts., Govt. Ind.*)

PORIFERA (SPONGES).

ANNANDALE, N. . . Notes on Freshwater Sponges. (*Rec. Ind. Mus., vii, 99.*)

,, ,, . . Systematic and Geographical Notes on the Sponges of Kumaon Lakes. (*Ibid., vii, 137.*)

,, ,, . . Freshwater Sponges and Polyzoa. (*Spolia Zeylan., viii, 133.*)

CŒLENTERATES.

ANNANDALE, N. . . Preliminary Description of a Freshwater Medusa from the Bombay Presidency. (*Rec. Ind. Mus., vii, 253.*)

,, ,, . . Note on a Freshwater Medusa from the Western Ghats. (*Journ. Asiat. Soc., Beng., vii, cxxiii.*)

ECHINODERMATA.

CLARK, A. H. . . On a small collection of recent Crinoids from the Indian Ocean. (*Rec. Ind. Mus., vii, 267.*)

VERMES.

ANNANDALE, N. . . Caridinicola, a new type of Temnocephaloidea. (*Rec. Ind. Mus., vii, 243.*)

,, ,, . . A Leech parasitic on the Hard-shelled Pond Tortoise of Ceylon. (*Spolia Zeylan., viii, 134.*)

CAMERANO, L. . . Gordiens du Musée Indien. (*Rec. Ind. Mus., vii, 215.*)

HORNELL, J. . . New Cestodes from Indian Fishes. (*Rec. Ind. Mus., vii, 197.*)

KHAN, M. . . . Notes on the rearing of leeches in Mawai, Bara Banki District, United Provinces. (*Rec. Ind. Mus., vii, 206.*)

LLOYD, R. E. . . Some disputed points in the anatomy of a common Indian earthworm. (*Journ. Bomb. Nat. Hist. Soc., xxi, 289.*)

POWELL, A. . . Note on above paper. (*Journ. Bomb. Nat. Hist. Soc., xxi, 291.*)

SOUTHWELL, T. . . A description of ten new species of Cestodes Parasites from Marine Fishes of Ceylon, with Notes on seven other species from the same region. (*Ceylon Marine Biol. Repts., i, 259.*)

STEPHENS, J. W. . The Liver-Fluke of the Indian Pariah Dog. (*Ann. Trop. Med. and Parasit., Ser. T. M., vi, No. 1, B., 117.*)

STEPHENSON, J. . . On a new species of *Branchiodrilus* and certain other aquatic Oligochæta, with remarks on cephalization in the Naididæ. (*Rec. Ind. Mus., vii, 219.*)

,, ,, . . Earthworms of Yunnan based on collections made by J. Coggin Brown. (*Rec. Ind. Mus., vii, 273.*)

CRUSTACEA.

HENDERSON, J. R. . Description of a new species of freshwater crab from Southern India. (*Rec. Ind. Mus., vii, 111.*)

KEMP, S., & SEWELL, R. B. S. Notes on Decapoda in the Indian Museum with special reference to the species obtained by the R.I.M.S. "Investigator" during 1910-1911. (*Ibid., vii, 15.*)

KEMP, S. . . Notes on Decapoda in the Indian Museum. (*Ibid., vii, 113.*)

,, ,, . . *Apus* from the United Provinces. (*Journ. Asiat. Soc., Beng., vii, cxi.*)

PEARSON, J. . Notes on the Alpheidæ. (*Spolia Zeylan., vii, 169.*)

WALTON, H. J., & KEMP, S. Notes on the occurrence of *Apus* in Eastern Asia. (*Rec. Ind. Mus., vii, 310.*)

ARACHNIDA.

GRAVELY, F. H. . . Mimicry of a Mutillid by a spider. (*Rec. Ind. Mus., vii, 87.*)

,, ,, . . Notes on Pedipalpi in the collection of the Indian Museum. (*Ibid., vii, 110.*)

,, ,, . . Remarks on the distribution of Pedipalpi. (*Journ. Asiat. Soc., Beng., vii, cxxiii.*)

GREEN, E. E. . On a remarkable Mimetic Spider. (*Spolia Zeylan., viii, 92.*)

HIRST, S. . . Descriptions of new Scorpions. (*Ann. Mag. Nat. Hist., viii (1st Ser.), 462.*)

INSECTA.

ALCOCK, A. . Entomology for Medical Officers.

ANNANDALE, N. . A new genus of short-beaked gnats from Ceylon. (*Spolia Zeylan., vii, 187.*)

,, ,, . . Further notes on flies of the genus *Phlebotomus*. (*Ibid., vii, 203.*)

,, ,, . . Description of a Micropterous fly of the family Phoridæ associated with ants. (*Ibid., viii, 85.*)

ANTRAM, C. B. . *Pœcilocoris latus*, Dall., *and Pœcilocoris hardwickii*, Westw. (*Quart Journ. Ind. Tea Assoc., pt. iv, 1911, 14.*)

ARROW, G. J. . . On some new species of the Lamellicorn Genus *Anomala* from Sikkim, North India. (*Ann. Mag. Nat. Hist., ix (8th Ser.), 1912, 72.*)

,, ,, . . Some new species of the Coleopterous Genus *Anomala* from Southern India. (*Ibid., viii (8th Ser.), 473.*)

,, ,, . . Descriptions of some new Burmese species of Rutcline Coleoptera belonging to the genus *Anomala*. (*Ibid., x (8th Ser.), 327.*)

BELL, T. R. . . The common Butterflies of the plains of India. (*Journ. Bomb. Nat. Hist. Soc., xxi, 517, 740.*)

BERGROTH, E. . . On some recently described Hemiptera chiefly from India. (*Ann. Soc. Entomol. Belgique, lv, 1911, 184.*)

BRUNETTI, E. . . Revision of the Oriental Tipulidæ with descriptions of new species. (*Rec. Ind. Mus., vi, 231.*)

,, ,, . . Annotated Catalogue of the Oriental Culicidæ—Supplement. (*Ibid., vi, 403.*)

,, ,, . . Description of *Aphiochæta ferruginea*, a hitherto undescribed species of Phoridæ that causes Myiasis in Man. (*Ibid., vi, 83.*)

,, ,, . . A new species of blood-sucking Fly (*Simulium*) from Ceylon. (*Spolia Zeylan., viii, 85.*)

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FOWLER, W. W. . Coleoptera, General Introduction and Cicindelidæ and Paussidæ. (*Fauna of British India.*)

FRASER, F. C. . . A note on *Polyommatus bæticus.* (*Journ. Bomb. Nat. Hist. Soc., xxi, 288.*)

FRAZER, —— . . Biological Notes on Indian Picrine Larvæ. (*Trans. Entom. Soc., Lond., 1911, xxvi.*)

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GRAVELY, F. H. . The habits of some tiger beetles from Orissa. (*Rec. Ind. Mus., vi, 207.*)

GREEN, E. E. . . Notes on the collection of Coccidæ in the Indian Museum. The genus *Margarodes.* (*Ibid., vii, 65.*)

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,, ,, . . On the occasional luminosity of the beetle *Harmatelia bilinea.* (*Spolia Zeylan., vii, 212.*)

,, ,, . . On an interesting aberration of *Vanessa (Pyrameis) indica.* (*Ibid., vii, 215.*)

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HAMPSON, G. F. . The Moths of India. (*Journ. Bomb. Nat. Hist. Soc., xxi, 411, 878.*)

HANCOCK, J. L. . Tettiginæ (Acridiinæ) in the Agricultural Research Institute, Pusa, with descriptions of new species. (*Mem. Dept. Agri., India, iv, No. 2, 1912.*)

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PALÆOSTRACA.

SEWELL, R. B. S. . Capture of *Limulus* on the surface. (*Rec. Ind. Mus., vii, 87.*)

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CHAUDHURI, B. L. . Freshwater Sting-Rays of the Ganges. (*Journ. Asiat. Soc., Beng., vii (new series), 625.*)

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ZOOLOGY.

II.—ECONOMIC ZOOLOGY.

Part I.—AGRICULTURAL ENTOMOLOGY.

BY

H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,
Imperial Entomologist.

Pusa Research Institute.—The study of the life-histories and habits of injurious and beneficial insects was continued at the Pusa Research Institute, the following species being specially studied:—

1. "Bherwa" (*Schizodactylus monstrosus*, Dr.).
2. Indigo Psylla (*Psylla isitis*, Buck.)
3. Fish Insect (*Lepisma* sp.).
4. White-ants (*Termes* spp.).
5. Grain and Flour Beetles (1. *Rhizopertha dominica*, Fabr.).
   (2. *Tribolium ferrugineum*, F. & T.).
   (3. *Lœmophlœus testaceus*, F.).
6. White Weevil (*Myllocerus maculosus*, Dasbr.).
7. Green Weevil (*Astycus lateralis*, Fabr.).
8. Cotton Stem Weevil (*Pempheres affinis*, Fst.).
9. Small Rice Grasshopper (*Oxya velox*, Fabr.).
10. Green Surface Grasshopper (*Atractomorpha crenulata*, Sss.).
11. White-banded Grasshopper (*Epacromia dorsalis*, Thunb.).
12. Mango Leafhopper (*Idiocerus*) 3 species.
13. *Ascalaphus* sp.
14. *Rhogas lefroyi*, Ashm. Ms.

Work on fruit flies was continued by the staff of the Imperial Pathological Entomologist.

In addition to the above some important field observations were made on the Sugarcane Fly (*Pyrilla lycoides*, Wlk.) and the Sugarcane Mealy Wing (*Aleurodes barodensis*, Mask.). Observations have also been recorded on pests occurring generally in India and a minute record kept of those occurring on the Pusa Farm.

At the request of the Bihar Planters' Association, an enquiry into the *Psylla* disease of indigo was taken up and is being continued. The experiments on the preservation of wood and other materials from the attacks of Termites (White-ants) are still in progress, and the efficacy of various preparations and the relative immunity of different kinds of wood is being tested. A new process was devised and proved effectual; it is the only wood treatment yet found wholly to resist White-ant attack. Some experiments with White-ants, which attack wheat and sugarcane crops, were also conducted. In conjunction with the Department of Agriculture, Bihar and Orissa, active part was taken in combating the "Surface Caterpillar" pest (*Agrotis ypsilon*, Roth.) which did enormous damage annually to "rabi" crops in the Mokameh Tal lands; and as a result of the remedial measures adopted the loss this year has been considerably reduced. The Andres-Maire system of trapping has been of great value in this campaign; it is still uncertain where this pest passes the monsoon period. Assistance was given to the Department of Agriculture, Punjab, in checking an outbreak of the Cotton Bollworm (*Earias insulana*, Boisd.) in that Province. It was anticipated that the cold winter of 1910-11 would be followed by a bollworm outbreak, and that parasites would be absent; the parasite was accordingly introduced and the measures adopted were attended with great success, the parasite, *Rhogas lefroyi*, Ashm. Ms., of the Cotton Bollworm being introduced, established and spread throughout the affected areas. Fuller information has been gained of this Cotton Bollworm and its parasites during the course of this campaign.

The experiments in crossing multivoltine and univoltine races of Mulberry Silkworms to secure a superior silk-producing multivoltine race have been continued; up to the present it has been impossible to produce a stable multivoltine race of worms, but progress has been made and the problem is narrowed down and more likely to be solved. Acclimatized univoltine races were successfully reared on pruned tree mulberry, wild mulberry and bush mulberry and arrangements have been made to distribute eggs of these univoltine races for rearing in

October. The cultivation of the eri silkworm was continued and experiments with crossing *Attacus ricini* and *A. cynthia* were performed with a view to obtain a hardy race of worms which will successfully stand the climatic conditions of Bihar. After repeated trials it has been found that the crosses are influenced in the same way as pure eri worms, and do not show any special advantage over the latter. It has been necessary to show the commercial possibilities of eri silk and a part of the energies of this Section is devoted to designing superior fabrics as models for those who have taken up the industry.

Experimental work in Lac-culture and the collection of the races of lac insects, in collaboration with the Forest Department, were continued. It is hoped that the material collected by Forest Officers will enable the problem of lac races to be solved.

Investigations into Apiculture have been continued. In November 1911 two colonies of American-Italian bees were imported and these have proved very successful; but so far all attempts to obtain fertilised queens for multiplying the colonies have failed, apparently on account of the activities of bee-eating birds which are common at Pusa. The yield per hive was high, but it has been impossible to get fertile queens, these being destroyed on the marriage flight; if queens can be imported this difficulty will be overcome. Trials have been made with the common Indian bee (*Apis indica*, F.) and success has been achieved in adapting the modern bar-frame hive to its requirements.

Provincial Departments.—In Madras experiments were continued for the control of the Deccan Grasshopper (*Colemania sphenarioides*, Bol.). Special attention has also been paid to the observations and rearing of the natural enemies of this grasshopper. Considerable damage having been caused to Cambodia cotton in the Coimbatore District by the attack of the Stem Weevil (*Pempheres affinis*, Fst.), a considerable amount of work has been done on its life-history with a view to control, but no satisfactory method of dealing with it has been found as yet. Some research work on Termites was carried out and in the course of this it was noted that the open-chambered termitaria found at Coimbatore regularly harbour numerous specimen of Sand-flies (*Phlebotomus minutus*) which probably breed in the débris collected in the galleries of the mound.

In Bombay experiments were carried out to devise best means of checking the ravages of two insect pests which considerably damage some valuable crops in Ahmedabad and Kaira Districts. These insects are (1) Katra (Hairy Caterpillars of which *Amsacta moorei*, Butl. is most prominent) and (2) the White-ants (*Termes* sp.).

In Baroda the campaign against "Katra" (*Amsacta* spp.) was continued.

From the Central Provinces the parasite *Rhogas lefroyi* was issued to the Punjab and Pusa. The cultivation of Eri Silkworms was experimentally tried and the work in connection with the mound-building Termites was continued at Hoshangabad.

In the North-West Frontier Province very successful spraying experiments against the Peach Aphis were conducted; and the efficacy of Maize as a trap crop for the Sugarcane Borer (*Chilo simplex*, Butl.) was tested.

In the Punjab vigorous measures were adopted to check an outbreak of the Cotton Bollworm (*Earias insulana*, Boisd.).

In the United Provinces methods of controlling the Potato Moth (*Phthorimœa operculella*, Zell.) were demonstrated, and also active measures were taken against *Hieroglyphus furcifer*, Serv., a serious pest of Sugarcane, in the Province. One Deputy Collector has been put on special duty at Shahjehanpur to work up the Eri Silk industry.

In Bihar and Orissa the campaign against the Surface Caterpillar pest (*Agrotis ypsilon*, Rott.) of the Mokameh Tal lands was continued and great success has been achieved in reducing the extent of damage done by the pest. Successful demonstrations of the methods of controlling the Potato Moth were given at the several Exhibitions and Shows which were held during the year under review, in the Province. Eri Silk cultivation was also taken up and some progress has also been recorded in this direction.

In Bengal several investigations were undertaken including "Ufra" disease of Rice, the Rice Ear-cutting Caterpillar (*Cirphis unipuncta*, How.) and the Mango Hairy Caterpillar (*Cricula trifenestrata*, Helf.).

In Burma, experiments to control the Peach Fly (*Dacus ferrugineus*, Var.) and to destroy the mound-building species of White-ants were conducted. The cultivation of Eri Silkworms was also experimentally taken up at Mandalay, without success.

In Mysore the Entomological staff of the Department of Agriculture was mainly occupied in the supervision of the extensive bagging operations against the Deccan Grasshopper (*Colemania sphenarioides*, Bol.) and the Rice Grasshopper (*Hieroglyphus furcifer*, Serv.) on both of which pests bulletins were issued. The investigations of the Kumblihula pest (*Amsacta albistriga*, Wlk.) have, with the end of this year, been

completed and the more important results have been embodied in a preliminary report issued in June this year. In the Insectary, work was mainly confined to various store pests and to experiments in devising remedies against them. The free living *Bruchid* and the Thogari Pod Fly have also been studied. Further rearing of *Opatrum depressum* has yielded very interesting results. Other insects of minor importance have been studied:—*Episomus lacerta, Orthacris acuticeps, Cryptophlebia carpophaga.*

Indian Tea Association.—The Entomologist to the Indian Tea Association investigated the question of damage done to Tea-chests by boring Beetles and the best means to prevent it. An enquiry into the injury to Tea seeds by the Tea Seed Bug (*Pœcilocoris latus*, Dall.) and the study of Mosquito Blight in the Duars were also taken up.

II.—ECONOMIC ZOOLOGY.

Part II.—FOREST ENTOMOLOGY.*

BY

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Forest Zoologist.

A.—Sanctioned Programme.

The sanctioned programme of research work consisted of the following items:—

(1) The study of all insects which cause serious damage to, or which are beneficial to the *sál* tree or its timber.

(2) Investigations regarding the lac insect.

(3) The preparation of a satisfactory reference collection of insects for the Research Institute.

(1) **Sal investigation.**—The writer toured in the *sál* forests of the Siwalik and Kheri Forest Divisions, United Provinces, during December 1911—March 1912.

* Mr. R. S. Hole officiated as Forest Zoologist from July to October 1911, after which period the present writer was appointed.

A good many insects likely to have economic importance have been collected and information relating thereto is being recorded in the research files. The longicorns *Æolesthes holosericea* and *Hoplocerambyx spinicornis* are the only widely distributed insects at present found to cause any lasting damage to the mature *sál*, and special attention is being devoted to the life-history of the first-mentioned species. From affected *sál* logs collected in the Siwalik forests during the cold weather of 1911-12 the mature beetles emerged in breeding cages in Dehra Dun from 13th April to 7th May 1912. Both *Hoplocerambyx spinicornis* and *Æolesthes holosericea* have been found to occur plentifully in the United Provinces and have been recently bred out in considerable numbers from one and the same tree.

Several dead *sál* trees containing larvæ of *Æolesthes holosericea* were felled at Thano, Siwalik Forest Division, United Provinces, and some parasitic Hymenoptera were bred out of these. The specimens were sent to Mr. P. Cameron, a leading authority, for identification, and have been identified by him as *Paroligosthænus trichiopthalmus*, gen. et sp. nov. Parasitic Hymenoptera collected from *sál* leaves at Kaluwalla, Siwalik Forest Division, have proved to belong to two new species of the genus *Iphiaulax* and have been described by Mr. Cameron as—

(1) *Iphiaulax sál*, sp. nov.

(2) *Iphiaulax Immsii*, sp. nov.

Their descriptions along with those of others bred out of lac, are being published as a Forest Record.

So far as at present ascertained, the *Monophlebus* scale and the *Pammene* moth larva are much more local pests. Specimens of the *Monophlebus* scale were received from the Pilibhit Forest Division of the United Provinces, and among them were discovered a large number of the larvæ of a species of Coccinellidæ (genus *Vedalia*), which, on their receipt, were found to have devoured a considerable proportion of the scale insects.

Some lepidopterous larvæ defoliating *sál* leaves were also received from the Pilibhit Forest Division. Three moths (family *Bombycidæ*) were bred out of these, and are at present awaiting identification.

Specimens of caterpillars and moths defoliating *sál* leaves were received from Mr. A. E. Osmaston, Divisional Forest Officer, Gorakhpur Division. The moth was identified as *Ingura subapicalis*, Walker. The other specimens being larvæ could not be identified with any amount of

certainty. From this Division specimens of a beetle (family *Curculionidæ*) attacking *sál* fruits were also received. The specimens have been sent to Mr. Marshall who is at present working at the Fauna of India volume on the family.

Caterpillars of the Noctuid moth *Ingura subapicalis*, Walker, were reported as doing damage to *sál* coppice forests of Chakia Range in the Bahraich Forest Division.

(2) **Lac investigation.**—Specimens of stick lac were received from the Sylviculturist and numerous parasitic insects were bred out of these. A large number of parasitic Hymenoptera, new to science, were bred out. These have been named and described by Mr. P. Cameron as follows:—(1) *Chalcis tachardiæ*, sp. nov., (2) *Cyclopleura claripennis*, gen. et sp. nov., (3) *Eurytoma pallidiscapus*, sp. nov., (4) *Brasema annalicaudis*, sp. nov., (5) *Lissencyrtus troupi*, gen. et sp. nov., (6) *Copidosoma? clavicornis*, sp. nov., (7) *Hadrothrix purpurea*, gen. et sp. nov., (8) *Bracon tachardiæ*, sp. nov., (9) *Ectadiophatnus tachardiæ*, gen. et sp. nov., (10) *Apanteles tachardiæ*, sp. nov.

Their descriptions are being published as a Forest Record.

Specimens of *Butea* stick lac were received from various Divisional Forest Officers of the Central Provinces, and the parasites are being bred out therefrom. A special study is being made of these parasites and their bearing on the production and propagation of lac.

In consequence of the fact that much of the literature at present available contains numerous errors relating to this insect, and very little first hand information, a study is being made of the structure and biology of the lac insect with special reference to Butea lac.

(3) **Reference collection.**—During the year 40 parcels of specimens were despatched to various specialists in Europe and America for identification. Among the specimens identified, the following new species, in addition to those mentioned above, have been described:—

(*a*) Cicadidæ by Mr. W. L. Distant—(1) *Khimbya immsi*, sp. nov., (2) *Dunbulia helena*, sp. nov., (3) *Quintilia pomponia*, sp. nov., (4) *Meimuna cassandra*, sp. nov.

(*b*) Dermaptera by Dr. Malcolm Burr—*Pseudisolabis immsi*, sp. nov.

(*c*) Staphylinidæ by Dr. Max Bernhauer—(1) *Medon immsi*, sp. nov.

(*d*) Hymenoptera by Mr. P. Cameron, F.E.S.—(1) *Centrochalcis ruficaudis*, sp. nov. (Chalcididæ), (2) *Cylopleura fumipennis*, gen. et sp.

nov. (Chalcididæ), (3) *Caloteleia rufipes*, sp. nov. (Scelionidæ), (4) *Immsia carinifrons*, gen. et sp. nov. (Scelionidæ), (5) *Lophyrus indicus*, sp. nov. (Tenthredrinidæ), (6) *Salius dehraessis*, sp. nov. (Pompilidæ), (7) *Liris nitidus*, sp. nov. (Sphegidæ), (8) *Trypoxylon ornatipes*, sp. nov. (Sphegidæ), (9) *Icaria annulipes*, sp. nov. (Vespidæ), (10) *Megachile stirostoma*, sp. nov. (Apidæ).

B.—Investigations outside the Sanctioned Programme.

1. **Major Subjects.**—(*a*) A species of Coccid attacking Chir pine in the Naini Tal Forest Division. The attack has been found to be both serious and widespread. The life-history of the Coccid is under investigation, and the writer has toured through Kumaon during May and June 1912 in this connection.

(*b*) A study of the various species of Termites found in Indian forests. Specimens of white-ants and notes relating to the damage wrought have been received from nearly all parts of India. Professor Dr. F. Silvestri of Portici, Italy, has undertaken to do the work of identification.

(*c*) Scolytidæ attacking Blue pine (*Pinus excelsa*) and Chir pine (*Pinus longifolia*) in the Chakrata Forest Division, reported by the Divisional Forest Officer.

2. **Minor Subjects.**—(*a*) The beetles *Xylotrupes gideon* from *Poisiana regia* trees, and *Baladiva walkeri*, Waterh., received from the Divisional Forest Officer, Meiktila Division, Burma.

(*b*) A Chrysomelid beetle, reported as devouring *Boswellia serrata* leaves, from the Poona Forest Division.

(*c*) *Monophlebus tamarindus*, Green, found on *Tamarix* and *Prosopis*, received from the Sukkur Forest Division, Sind.

(*d*) Bruchid beetles attacking seeds of *Albizzia amara* and *Albizzia Lebbek*, received from the Bellary Forest Division, Madras.

(*e*) *Trilocha varia*, Walker, defoliating *Ficus elastica* leaves, received from the Conservator of Forests, Northern Circle, Madras. There is no previous record of this moth attacking *Ficus elastica*.

(*f*) The longicorn beetles *Epepeotus uncinatus*, Gahan, and *Haplohammus punctifrons*, Gahan, attacking rubber plants in the Lakhimpur Forest Division. There is no previous record of these beetles attacking rubber plants.

(*g*) Scale insects (probably a new species of *Pulvinaria*) attacking Nim trees in Mayo College, Ajmer. The Noctuid moth *Eublemma scitula*, Rmbr., parasitic on the scale insects, was bred out at the Research Institute.

(*h*) Two species of Bostrichid beetles, *e.g.*, *Sinoxylon anale*, Les., and a larger species closely allied to, or likely only a variety of, *Sinoxylon crassum*, Les., attacking shisham logs in Dehra Dun.

(*i*) Scolytid beetles attacking Padauk logs in the Andamans.

(*j*) Hepialid (?) larvæ, reported as boring into the stems of teak saplings, from the South Malabar Forest Division, Madras.

(*k*) The larvæ of the Noctuid moth *Ingura* (*Abrostola*) *subapicalis*, Walk., defoliating *sál* coppice forests of Chakia Range, Bahraich Forest Division.

(*l*) Curculionid beetles attacking *sál* fruits in the Gorakhpur Forest Division.

(*m*) Some caterpillars and the Noctuid moth *Ingura subapicalis*, Walk., reported as defoliating *sál* leaves from the Gorakhpur Forest Division.

The insects bred out of seeds of *Cassia fistula*, *Albizzia Lebbek*, *Dalbergia paniculata* and *Bauhinia malabarica*, sent by the Sylviculturist, mentioned in last year's report, were identified as follows:—

(1) Out of *Cassia fistula* seeds—*Caryoborus gonagra*, Fabr., *Trachylepidia fructicassiella*, Rog.

(2) Out of *Albizzia Lebbek*—*Stathmopoda basiplectra*, Meyr., sp. nov.

(3) Out of *Dalbergia paniculata*—*Bruchus theobramæ*, L.

(4) Out of *Bauhinia malabarica*—*Caryoborus gonagra*, Fabr.

From among the insects bred out of sundri wood mentioned in last year's report the longicorn beetles and parasitic Hymenoptera have been identified as follows:—

Longicornia (1) *Diorthus simplex*, White, (2) *Derolus discicollis*, Gahan.

Parasitic Hymenoptera (3) *Centrochalcis ruficaudis*, Cam., gen. et sp. nov., (4) *Paroligosthenus trichiopthalmus*, Cam. gen. et sp. nov.

The Buprestid beetles bred out of this wood have been sent to Dr. Ch. Kerremans of Brussels for identification.

3. **Miscellaneous.**—The following are the only additions to the Museum collection during the year worth mentioning:—

(*a*) Mounted specimens of rats and hares damaging Babul seedlings in the Buldana Division.

(*b*) Ants' nest, received from Mr. A. J. Butterwick, Burma.

(*c*) Termites' nest, received from the Haldwani Forest Division, United Provinces.

Specimens have been contributed during the year to the British Museum, Indian Museum, Pusa, and to several specialists.

About 1,600 research files have been opened and the information relating to each insect has been recorded therein.

A Card Index Catalogue of all insects recorded up to date as being injurious to the more important Indian forest trees has been prepared and completed.

Help in the identification of various insects has been generously given by Sir George Hampson, Mr. G. J. Arrow, Mr. Gahan, Mr. C. Morley, Dr. Malcolm Burr, Dr. Max Bernhauer, Professor F. Silvestri, Mr. W. L. Distant, and Dr. W. W. Fowler.

List of Publications on Economic Zoology.

Bainbrigge Fletcher, T.		Weevil and Dry Wheat. (*Agri. Journ. Ind., October 1911.*)
,,	,,	A simple Honey-Extractor. (*Agri Journ. Ind., October 1911.*)
,,	,,	The Wax Moth. (*Agri. Journ. Ind., October 1911.*)
,,	,,	The Cabbage White Butterfly. (*Agri. Journ. Ind., January 1912.*)
,,	,,	The Moth-borer in Canes. (*A pamphlet published by the Dept. of Agri., United Provinces.*)
Coleman, L. C.		*The Rice Grasshopper. (*Mysore Entomological Bull. No. 1.*)
,,	,,	*Jola or Deccan Grasshopper. (*Mysore Entomological Bull. No. 2.*)

* Publications which were mentioned in the last year's report but issued during the year under review.

COLEMAN, L. C. .	. "Kumblihulas" attacking crops in Mysore (*Amsacta albistriga*, Wlk.). (*Mysore Entomological Bull. No. 3.*)
DE, M. N. .	. Grasserie in Silkworms. (*Agri. Journ. Ind., July 1911.*)
DEPARTMENT OF AGRICULTURE, BENGAL.	Leaflet in Bengali on the Rice Ear-cutting Caterpillar (*Cirphis unipuncta*).
DEPARTMENT OF AGRICULTURE, BIHAR AND ORISSA.	Leaflets in English and Hindi on the Surface Caterpillar pest (*Agrotis ypsilon*) of Mokameh Tal lands.
,, ,,	Leaflets in Bengali and Ooriya on the Potato Moth (*Phthorimæa operculella*).
DEPARTMENT OF AGRICULTURE, BURMA.	Leaflets in English and Burmese on:— 1. The Common Hairy Caterpillar (*Diacrisia obliqua*). 2. Fruit Flies. 3. The Spotted Bollworm of Cotton. 4. The Brown Coccid on Cotton. 5. Field Crickets.
DEPARTMENT OF AGRICULTURE, MADRAS.	Leaflets in English on:— 1. Light traps. 2. Bambachu (*Leptocorisa varicornis*) and how to combat it. 3. Cocoanut Beetles.
DEPARTMENT OF AGRICULTURE, PUNJAB.	Leaflets in English, Urdu and Gurmukhi on the Cotton Bollworm.
DEPARTMENT OF AGRICULTURE, UNITED PROVINCES.	Short articles in Urdu on:— 1. Cut Worms in Tobacco, Potato and Poppy fields. (*Mufid-ul-Muzarain, January 1912.*) 2. Termites. (*Mufid-ul-Muzarain, February 1912.*) 3. Rice Grasshopper. (*Mufid-ul-Muzarain, March 1912.*)
DUTT, H. L. .	Insect Pests of Jute. (*Bengal Quarterly Journ. Agri., October 1911.*)
,, ,,	Swarming Caterpillars on Paddy at Sabour. (*Bengal Quarterly Journ. Agri., January 1912.*)

GHOSH, C. C. . .	*Life-Histories of Indian Insects, III. The Rhinoceros Beetle and the Red Palm Weevil. (*Mem. Dept. of Agri., India, Entomological Series, ii, No. 10.*)
HOLE, R. S. . .	Note on the Bark-boring beetle attack in the coniferous forests of the Simla Catchment Area. (*For. Bull. No. 12.*)
INDIAN TEA ASSOCIATION.	Damage by Beetles in Tea Chest Woods. (*Pamphlet No. 1, 1912.*)
IYER, V. S. . .	Note on some Casuarina Insect Pests of Madras. (*For. Bull. No. 11.*)
KHAMPARIA, R. R. .	Moth-borer in Sugarcane, Juar and Maize. (*Agricultural Gazette of Cent. Prov., July 1911.*)
MACKENNA, J., & SHROFF, K. D.	The Rhinoceros Beetle and its ravages in Burma. (*Burma Agri. Dept. Bull. No. 4, 1910.*)
MAXWELL-LEFROY, H.	Bulletin No. 23 on Insecticides, 2nd edition, revised by T. Bainbrigge Fletcher.
MAXWELL-LEFROY, H., & GHOSH, C. C.	*Eri Silk. (*Mem. Dept. of Agri., India, Entomological Series, iv, No. 1.*)
MISRA, C. S. . .	Cotton Bollworms, an Article in Urdu. (*Mufid-ul-Muzarain, March 1911.*)
NOWROJEE, D. . .	*Life-Histories of Indian Insects, II. Some Aquatic Rhynchota and Coleoptera. (*Mem. Dept. of Agri., India, Entomological Series, ii, No. 9.*)
STEBBING, E. P. . .	Note on some Insect Pests of the Himalayan Coniferæ (*Pinus longifolia*). (*For. Mem., Vol. ii, Pt. ii.*)
,,	The Blue Pine Tomicus Bark-borer. (*For. Bull. No. 5.*)
,,	Note on the Bark-eating and Root-boring beetles of Babul. (*For. Bull. No. 10.*)
WOODHOUSE, E. J. .	The "Potato Moth" in Bengal. (*Bengal Quarterly Journ. Agri., January 1912.*)

* Publications which were mentioned in the last year's report but issued during the year under review.

VETERINARY SCIENCE.

BY

COLONEL H. T. PEASE, C.I.E., F.L.S., F.R.M.S.,
Principal, Punjab Veterinary College.

The following table shows the output and issue of the various products at the Imperial Bacteriological Laboratory at Muktesar:—

Name.	Quantity prepared.	Issued.
	Doses.	Doses.
Anti-Rinderpest Serum	1,052,500	698,100
Anthrax Serum	28,722	6,070
Hæmorrhagic Septicæmia Vaccine	33,700	33,700
Anti-Hæmorrhagic Septicæmia Serum	30,845	28,970
Charbon Symptomatique Vaccine	60,000	15,350
Mallein	20,644	16,480
Tuberculin	519	577
Anti-Streptococcic Serum	1,294	2,298

Rinderpest.—Major J. D. E. Holmes, M.A., D.Sc., M.R.C.V.S., has been chiefly employed during the year in studying the new method of preparing Anti-Rinderpest Serum which was reported last year. With a view to improving the technique for this purpose he has investigated the potency of serum taken after natural recovery from plains cattle and buffaloes and from hill cattle; the comparative value of serum taken at repeated bleedings and also the most suitable volume of virus for injection purposes. The system of preparation noted last year has been adopted as a routine method for India. It has proved to be far superior to the older method. Plains cattle and buffaloes which yield a far larger amount of serum than hill bulls can be utilized and consequently a very much larger quantity of serum can be prepared at less expense and labour.

We are now free from the incubus of the hill bull problem to a great extent and the necessity for a new serum laboratory does not exist

as the quantity of serum which it is possible to prepare at Muktesar is sufficient to meet the requirements of the country for some years to come.

Captain R. C. Cochrane, A.V.C., has been engaged in the immunization of military cattle against Rinderpest by the simultaneous method and has published a very valuable contribution to our knowledge of the effect of the use of the serum in the field. The special value of the report lies in the fact that as the cases were under observation continuously correct records were kept and consequently the information is reliable. The lowest dose for plains cattle at present is 5 c.c. per 600 lbs. body weight, the calculation being made at $\frac{1}{18}$, the dose required to protect the most susceptible bovine in India, *i.e.*, the hill bull, but Cochrane considers the calculation for plains should be not $\frac{1}{18}$ but $\frac{1}{5}$ or thereabouts, giving a standard plains dose of 20 c.c. This is the dose fixed by the Conference on Anti-Rinderpest Inoculation for military dairy cattle. It seems probable that it would be fair to issue at a minimum dose of 10 c.c. per 600 lbs. body weight and that a dose of 20 c.c. should be used in dairy cattle or at the beginning of an outbreak. Captain Cochrane's report fixes the average susceptibility in plains cattle at the old estimate, *i.e.*, 30 to 40 per cent. of mortality in untreated cases and 60 to 70 per cent. of considerable immunity. If Anti-Rinderpest serum is used early in an outbreak when the more susceptible animals have to be protected a dose of 20 c.c. is necessary. When the operations are undertaken late, the more susceptible animals have been attacked and only the resistant remain. In such cases a smaller dose suffices, and probably 10 c.c. is the safest.

Owing to the increased output of serum the restrictions in regard to its issue and the prohibition of sale to outside countries have been removed and a larger amount has been issued during the year.

A charge of two annas per dose has been imposed: this is borne by Provincial Governments in all Provinces except the Punjab where a charge is made to the peasant.

Hæmorrhagic Septicæmia.—During the winter at Bareilly, Major Holmes made experiments regarding the vitality of the Hæmorrhagic Septicæmia virus outside the animal body and the means by which infection is retained and disseminated. The investigations are not yet complete and are being continued.

Recent observations at Hissar point strongly to the fact that the bacterium is not communicated by means of an invertebrate intermediary

host, but is purely soil-borne and remains alive for a very long time in wet soil, in fact that it can live as a saprophyte as is generally supposed.

Mr. S. H. Gaiger collected a considerable amount of information regarding the connection of outbreaks of the disease with rainfall and has proved conclusively that although the disease is more prevalent after rain it occurs quite independently of it.

Major F. S. H. Baldrey in collaboration with Dr. P. Hartley records experiments regarding a sensitised vaccine for the disease, the sensitising being accomplished by means of a heated specific serum to avoid bacteriolysis. The vaccine thus prepared appears to give immediate immunity thus obviating the objectionable negative phase. Such a vaccine would be very valuable in India as it would supplant serum which is of very doubtful value as a means of dealing with the disease in the field.

Major G. K. Walker submitted a short report on observations of the use of the serum in the field. The issue is at present only in an experimental stage.

Anthrax.—Major J. D. E. Holmes reports that during the winter at Bareilly, further experiments were carried out regarding the value and practical application of sero-vaccination against Anthrax by means of a combined injection of serum and virus or serum and a vaccine and that the experiments are being continued.

The serum manufactured is chiefly issued to Eastern Bengal and Assam for use against actual outbreaks. The disease does not appear to be very prevalent in other places.

Surra.—Major Holmes has treated a few more naturally acquired cases in equines on the old lines, the result being 68 per cent. of recoveries. The treatment of Surra by this method may be relied on to give from 50 to 60 per cent. of recoveries when the conditions are favourable. The cases must be got pretty early, placed in a good climate, be rested and well fed during the treatment, otherwise the results are disappointing and do not justify the expense.

Experiments have been made in the treatment of Surra in the dog by means of Salvarsan, but the drug does not appear to be a satisfactory one for the purpose.

Mr. A. S. Leese, M.R.C.V.S., the officer investigating camel diseases, has continued his investigations into the curative treatment of Surra in the camel. Early in the year it had been recognised that cures had been obtained by the use of judicious combinations of Atoxyl

or Soamin, Tartar emetic and Sodium arsenate or Arsenious acid. The more recent experiments have been attended by considerable success, 30 camels cast from camel corps have been cured and a percentage of 50 to 62 obtained—a very great advance.

This officer made a long tour in Sind and a short one in Baluchistan for the purpose of collecting information regarding the prevalence of the disease in those Provinces and has submitted a report on the subject.

Kumri.—Major Holmes reports that he is investigating this disease in collaboration with Professor Mott, F.R.S., who is carrying out the pathological portion. No definite results have so far been obtained.

Spirochætosis.—Spirochætosis of fowls is a very fatal and widespread disease in India. In view of the fact that expensive English fowls are being imported into the country and as they are specially susceptible, Mr. Leese made experiments with a view to finding a cure. He reports that Soamin in $\frac{1}{4}$ to $\frac{1}{8}$ of a grain according to size of the fowl will, if injected into the breast muscles, cure a case.

Piroplasmosis.—Mr. S. H. Gaiger has published a paper on the experiments made in the Punjab Veterinary College regarding the treatment of canine piroplasmosis by means of Trypanblau. His experiments appear to confirm Patton's observations regarding the presence of two species of piroplasms in the dog in India, one destroyed by Trypanblau and the other unaffected by it.

Considerable success has been obtained in Madras by Major Symons, I.M.S., and Captain Patton in the treatment of the disease by Salvarsan.

Filariasis.—Mr. A. S. Leese has continued his studies into camel filariasis as it occurs in India and has published a paper describing the parasite, the effects of the embryos on the host, the duration and course of the disease produced and discussing the probable agent of infection. The paper is a valuable contribution to our knowledge of the subject.

Parasites.—Mr. Leese reports the occurrence of Bilharziosis in the camel. *Thelazia leesei* (Raillet & Henry) has also been described as an extra ocular nematode of the camel.

The same author reports on the probable connection between Linguatula larvæ and Peritonitis in the camel.

Mr. S. H. Gaiger records the occurrence of a new extra ocular filaria of the dog, which has been named *Thelazia callipæda* (Raillet & Henry).

The same observer has found a new nematode in sheep and cattle. The parasite belongs to a new sub-genus and a new species and has been named *Gaigeria pachyscelis*.

Some investigations have been made regarding the percentage of infestation of the dog and the treatment of parasitism.

A List of Papers published during the year 1911-12 bearing on Indian diseases.

BALDREY, F. S. H. Feeding and immunity in Hæmorrhagic Septicæmia and Rinderpest. (*Journ. Trop. Vet. Science, vi, No. 2.*)

" " A culture method for hyperimmunizing animals for the production of Anti-Rinderpest Serum. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Sensitised vaccine in Hæmorrhagic Septicæmia. (*Journ. Trop. Vet. Science, vi, No. 3.*)

The evolution of *Trypanosoma evansi* through the fly: *Tabanus* and *Stomoxys*. (*Journ. Trop. Vet. Science, vi, No. 3.*)

An undescribed organism pathogenic to laboratory animals, cattle and sheep. (*Journ. Trop. Vet. Science, vi, No. 3.*)

BALFOUR, ANDREW. The rôle of the infective granule in certain protozoal infections as illustrated by the Spirochætosis of Sudanese fowls. (*Journ. Trop. Med. & Hyg.*)

Various subjects. (*Report of the Wellcome Research Laboratories.*)

BRUCE, SIR DAVID, HAMERTON, BATEMAN & MACKIE. Trypanosome diseases of domestic animals in Uganda "Trypanosoma pecorum." (*Proc. Roy. Soc., vol. 82 B. 558.*)

Experiments to ascertain if cattle may act as a reservoir of the virus of sleeping sickness *Tr. gambiense*. (*Sleeping Sickness Commn. Rep.*)

Trypanosome diseases of domestic animals in Uganda—II, III *Tr. vivax*, IV *Tr. uniforme*, V *Tr. nanum*.

Trypanosoma gambiense development in *Glossina palpalis*. (*Proc. Roy. Soc., Series B, 85 B. 567.*)

Experiments to ascertain if certain *Tabanidæ* act as the carriers of *Trypanosoma pecorum*. (*Proc. Roy. Soc., B. 565.*)

Experiments to ascertain if antelope may act as a reservoir of the virus of *Trypanosoma gambiense*. (*Sleeping Sickness Commn. Rep.*)

Amakebe, a disease of calves in Uganda. (*Journ. R. A. M. C., 10, No. 5.*)

BURTON CLELAND, J. Endemic hæmaturia in cattle due to Angiomata in the bladder; its possible relation to Pentastomiasis. (*Journ. Trop. Vet. Science, vi, No. 2.*)

An early reference suggestive of the transmission of disease (Trypanosomiasis) by flies. (*Journ. Trop. Vet. Science, vi, No. 2.*)

BURTON CLELAND, J., & HARVEY JOHNSTON, T. On the anatomy and possible mode of transmission of *Filaria (Onchocera) gibsoni*. (*Proc. Roy. Soc. N. S. W., xliv.*)

COCHRANE, R. C. . Inoculation against Rinderpest in India by the serum simultaneous method. (*Journ. Trop. Vet. Science, vi, No. 2.*)

CONDER, G. . . Treatment of Anthrax by hypodermic injections of carbolic acid. (*Journ. Trop. Vet. Science, vi, No. 4.*)

DARLING, SAMUEL T. . Equine Trypanosomiasis in the Canal zone. (*Bull. de la Soc. de Path. Exot., iii, No. 6.*)

The probable mode of infection and the methods used in controlling an outbreak of equine Trypanosomiasis (Murrina) in the Panama Canal zone. (*Parasitology, 10.*)

DELANOE, P. . . Présence de trypanosomes chez les bovidés en France. (*Bull. de la Soc. de Path. Exot., iv.*)

DUBOIS, M. . . Divers cas de Fièvre de Malta d'origine ovine, chez l'homme. (*Rev. Vet., 9.*)

FANTHAM, DR. . . The life-history of *Trypanosoma gambiense* and *T. rhodesiense* as seen in rats and guinea-pigs. (*Proc. Roy. Soc., 83, B.*)

FRANCA, C. . . Classification des Piroplasmes. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*)

Description de deux formes des piroplasmes. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*)

Sur un Trypanosome de Lérot. (*Archiv. do Real. Inst. Bact. Cam. Pest., iii.*)

GAIGER, S. H. . . Notes on Parasites. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Canine piroplasmosis. (*Journ. Trop. Vet. Science, vi, No. 4.*)

GILCHRIST, J. D. F. . The intermediate host of the liver fluke in South Africa. (*Natal Agric. Journ.*)

GILRUTH, J. A. . . Note on a protozoan parasite found in the mucous membrane of a sheep. (*Bull. de la Soc. de Path. Exot., iii, No. 5.*)

Note on the existence of Spirochætosis in fowls in Victoria. (*Proc. Roy. Soc. Vict., 23, p. 1.*)

GOGEL, L. S. . . *Filaria immitis* chez les chiens de Transcaucasie. (*Zeits. fur wissen ü prakt Vet., iii.*)

HARMS, ERIC . . Chemo-therapeutische Versuche bei der Nagana. (*Arch. fur wissen. und Prakt Tier, 96, 4 & 5.*)

HARVERY, W. F., & MARKHAM CARTER, R. Pyocyaneus infection in dogs and its similarity to rabies. (*British Med. Journ.*)

HECKINROTH, F. . Essai d'obtention d'une race de Nagana résistante à l'émétique. (*Ann. de l'Institut Pasteur, xxiv.*)

HERRING, L. . . Texas tick fever and Brahma cattle. (*Amer. Vet. Rev.*)

JOWETT, WALTER . Note on a Cattle Trypanosomiasis of Portuguese East Africa. (*Journ. Trop. Vet. Science, vi, No. 2.*)

LAFONT, A. . . Récherches sur le surra a Maurice. (*Apercu general sur le travail du Lab. de Bact., Maurice.*)

LAUFRANCHI, ALEXANDRA. Studi ematologica in cani affeti sperimentale da Surra. (*Le Clinica Vet., xxxiii, Nos. 4, 5 & 6.*)

LAVERAN, A. . . Au sujet de *Trypanosoma dimorphon* et de *Trypanosoma Congolense*. (*Bull. de la Soc. de Path. Exot., iii.*)

Trypanosoma cazalboui ne doit pas être identifie à *Trypanosoma vivax*. (*Bull. de la Soc. de Path. Exot., 10.*)

Au sujet de *Trypanosoma brucei* sans blepharoplast. (*Bull. de la Soc. de Path. Exot., 10.*)

Du traitement par l'orpiment des infections produites par *Trypanosoma Congolense* et *par Trypanosoma dimorphon*. (*Bull. de la Soc. de Path. Exot., iii.*)

De l'efficacité d'un emetique d'arsenic et d'aniline dans le traitement de différente trypanosomiases. (*C. R. de l'Acad. des Sciences, 151, No. 13.*)

Resistance des chêvres et des moutons aux trypanosomiases: longue durée de l'immunité à la suite de ces maladies. (*C. R. de la Soc. de Biol., 152.*)

Contribution à l'étude de *Trypanosoma hippicum* (Darling). (*Bull. de la Soc. de Path. Exot., iv.*)

Au sujet de *Trypanosoma pecorum* (Bruce). (*Bull. de la Soc. de Path. Exot., iii.*)

Identification and an attempt to classify the Trypanosomes of Mammals. (*Annales de l'Institut Pasteur, J. T. V. S., vii.*)

LEESE, A. S. . . Indian Camel filariasis. (*Journ. Trop. Vet. Science, vi, No. 4.*)

Bilharziasis in the Camel. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Soamin treatment of Indian fowl spirochætosis. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Linguatula larvæ and peritonitis in the Camel. (*Journ. Trop. Vet. Science, vi, No. 3.*)

Third series of experiments on treatment of Surra in Camels. (*Journ. Trop. Vet. Science, vii, No. 1.*)

LEESE, A. S. . . Biting flies and Surra. (*Journ. Trop. Vet. Science, vii, No. 1.*)

Second note on the treatment of Indian fowl spirochætosis. (*Journ. Trop. Vet. Science, vii, No. 1.*)

Annual report of the Veterinary Officer investigating Camel diseases.

LEVADITI, C., & NATTAN LARRIER. Traitement de la piroplasmose canine par Arsenobenzol. (*Bull. de la Soc. de Path. Exot., iii.*)

LUCET, M. . . . Sur la présence de spirochetes dans un cas de gastro-entérite chez le chien. (*C. R. de l'Acad. des Sciences, 151, No. 3.*)

MARTIN, G., & RINGEMBACH. Étude expérimentale du *Trypanosoma Congolense*. (*Bull. de la Soc. de Path. Exot., iv.*)

MASON, F. E. . . Sarcocysts in the Camel in Egypt. (*Journ. Comp. Path. & Ther.*)

Note on the Camel Trypanosomiasis of Egypt and results of first series of experimental drug treatment. (*Journ. Comp. Path. & Ther., xxiv, No. 1.*)

MATHIS, C., & LEGER, M. Nouvelles récherches sur *Leucocytozoon sabrazesi* et *Leucocytozoon cautleryi* de la poule domestique à Tonkin. (*Bull. de la Soc. de Path. Exot., iv.*)

Fasciolopsis buski au Tonkin. (*Bull. de la Soc. de Path. Exot., iv.*)

MELLO, UGO . . Un cas de Toxoplasmose du chien observe à Turin. (*Bull. de la Soc. de Path. Exot., iii.*)

MESNIL, F. . . The identification of some Pathogenic Trypanosomes. (*Bull. de la Soc. de Path. Exot., iii.*)

De l'action comparé de serums de Primates sur les infections à Trypanosomes. (*C. R. de la Soc. de Biol., lxix.*)

MITTER, S. N. . . Note on *Gnathostomum spinigerum*. (*Parasitology, v, No. 2.*)

Demodex bovis. (*The Vet. Rec., xxiv, No. 1240.*)

The anatomy of *Gnathostomum spinigerum*. (*Calcutta Med. Journ.*)

MITTER, S. N. . . Index catalogue of the animal parasites in the Bengal Veterinary College. (*Bengal Govt. pub.*)

NEGRE, L. . . . The intestinal stage of Sarcosporidia. (*C. R. de la Soc. de Biol., lxviii.*)

NEGRE, L., & BRIDRE, I. On the nature of the parasite of Epizootic lymphangitis. (*C. R. de l'Acad. des Sciences, 150.*)

NEUMANN, L. G. . Verminous dermatosis of the dog. (*Journ. Trop. Vet. Science, vii, No. 1.*)

OZOUX, M. . . . La filaire de l'œil du dindon. (*C. R. de la Soc. de Biol., lxviii.*)

PORTIER, P. . . Destruction des larves de gastrophilus fondé sur la connaisance de la physiologie de leur appareil respiratoire. (*C. R. de la Soc. de Biol., lxviii.*)

PROBST . . . Uber sarcosporidienbefunde im Blut. (*Arch. für Schiffs und Tropen. Hygiene, xiv.*)

RAILLET, A., & HENRY, A. Rechérches sur les ascarides des Carnivores. (*C. R. de la Soc. de Biol., lxxviii.*)

Essais sur la prophylaxie et le traitement de la distomatose. (*Rec. de Med. Vet., lxxxviii.*)

Nouvelles observations sur les Thelazies nematodes parasites de l'œil. (*C. R. de la Soc. de Boil., lxviii.*)

SCHEIN, H. . . Prophylaxie du Surra en Indo-Chine. (*Bull. de la Soc. de Path. Exot., iv.*)

SCHÖNEBECK, DR. . Beobachtung einer anscheinand pathogenen zur gruppe *Trypanosoma theileri* gehorigen Trypanosoms in Deutsch-Ostafrika. (*Arch. für Schiffs und Tropen. Hygiene, xiv.*)

SERGENT, ED. & ET. . Présence des Trypanosomes sur les bovidés d'Alger. (*Bull. de la Soc. de Path. Exot., 10.*)

Existence de la Leishmaniose chez les chiens d'Alger. (*Bull. de la Soc. de Path. Exot., iv.*)

SIEBER, H. . . Uber anaplasma marginale. (*Ber. Tur. Wachen, No. 50.*)

STRICKLAND, C. . . The mechanism of transmission of *Trypanosoma lewisi* from rat to rat by the rat flea. (*British Med. Journ., 2627.*)

STRONG, RICHARD P., & LEAGUE, O. The treatment of Trypanosomiasis with special reference to Surra. (*Philippine Journ. of Science.*)

TEPPAZ, L. . . . Contribution à l'étude de lymphangite épizootique. (*Bull. & Mem. de la Soc. des Sciences Vet. de Lyon.*)

Essais de traitement de la lymphangite épizootique du Senegal. (*Bull. de la Soc. de Path. Exot., iii.*)

THEILER, DR. A. . The immunity of horses against Horse Sickness. (*Transvaal Agri. Journ., vii.*)

The immunity of mules against Horse Sickness. (*Transvaal Agri. Journ., vii.*)

A contribution to our knowledge of gall sickness. Anaplasmosis of Cattle. (*Transvaal Agri. Journ.*)

VANET, CLEMENT M. Recherches sur le développement de l'hypoderma du bœuf. (*C. R. de l'Acad. des Sciences, 152.*)

WALKER, E. L. . The schizogony of *Trypanosoma evansi* in the spleen of the vertebrate host. (*Philippine Journal of Science, vii, No. 1.*)

YAKIMOFF, W. L. . La piroplasmose des chiens en Russie. (*Bull. de la Soc. de Path. Exot., iv.*)

Sur la présence de Trypanosomes dans le sang des bovides à Tunis. (*Bull. de la Soc. de Path. Exot., iv.*)

YORKE, WARRINGTON. Auto-agglutination of red cells in Trypanosomiasis. (*Proc. Roy. Soc., B, 83.*)

ZURICK & FISHER . Untersuchungen uber die Beschalseuche. (*Arb. aus dem Kais. Ges., xxxvi, Heft 1.*)

APPENDIX.

REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30TH SEPTEMBER 1912.

BY

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Director, Imperial Institute.

The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended the 30th September 1912 are as follows:—

Opium.—In connection with the chemical investigation of Indian opium which has been conducted at the Imperial Institute, it has been found necessary to devise a new method of estimating codeine in opium, and a paper on the subject has been communicated by Mr. A. E. Andrews of the Scientific Staff of the Imperial Institute to the Society of Public Analysts, and published in the "Analyst" (1911, Volume 36, page 489).

A series of botanical specimens of the varieties of poppy cultivated in India for the preparation of opium was forwarded from the Imperial Institute to Kew for identification. It was found that all the specimens represented varieties of the true opium poppy, *Papaver somniferum*, Linn.

Samples of Indian medicinal opium have been supplied by the Imperial Institute to a London hospital for practical trial in comparison with Turkey opium, but the results of the experiments are not yet available.

Solanaceous Drugs.—A paper giving the results of special scientific interest obtained in the course of the work on Solanaceous drugs, alluded to in previous reports, has been communicated by Mr. A. E. Andrews of the Imperial Institute Staff to the Chemical Society of London and published in the Society's Transactions (1911, Volume 98, page 1871).

Tobacco.—In continuation of previous investigations, two further samples of tobacco from the Government Farm at Burirhat were received

for examination and valuation. Both samples were found to be of marketable quality as pipe tobaccos, whilst one of them might be suitable for use as a cigar "wrapper." A London firm of tobacco merchants expressed a desire to be placed in touch with exporters of this tobacco in India, and were referred to the Director General of Commercial Intelligence at Calcutta, who had forwarded the specimens.

During the year the Imperial Institute procured for the Director of Agriculture at Dacca typical samples of various tobaccos marketed in London, to be used as standards of quality at Burirhat.

Tanning Materials.—A sample of *Acacia Catechu* extract prepared experimentally in Gwalior was found to contain a low percentage of tannin, due to the extract having been insufficiently concentrated. Suggestions for the improvement of the extract were made in the report.

Essential Oils.—Lemongrass oil. In continuation of the action previously taken, a second small consignment of this oil, distilled from four varieties of lemongrass grown at Wahjain, was forwarded to the Imperial Institute for examination and sale in London. The greater part of the consignment was disposed of to a firm of soap-makers at 4*d.* per oz., and the remainder at the same price to a dealer in essential oils who wished to have a small quantity for submission to customers. This dealer subsequently informed the Imperial Institute that he was able to place orders for the oil, and was put into communication with the Director of Land Records and Agriculture in Assam with a view to obtaining consignments of the oil from native distillers.

A consignment of cuscus roots (*Vetiveria zizanioides*) from Trichinopoly was examined in order to determine their value as a source of vetiver oil. The roots were found to be of inferior quality, giving a low yield of somewhat abnormal oil, so that it was doubtful whether they would be readily saleable at good prices in Europe.

The chemical examination of the oil of "Nepal sassafras" or "camphor wood," *Cinnamomum glanduliferum*, was completed during the year, the results being of considerable scientific interest. A paper on the chemistry of the oil by Dr. S. S. Pickles of the Imperial Institute has been communicated to the Chemical Society of London and published in that Society's Transactions, 1912, Volume 101, page 1433. The commercial value of the oil was under investigation at the end of the year.

Turpentine Oil.—Two samples of crude and rectified turpentine oil, prepared from the oleo-resin of *Pinus longifolia* by the Forest Chemist at Dehra Dun, were examined. The rectified oil appeared to be

quite suitable for paint and varnish-making, but it differed considerably in composition from the best American and French turpentine oils. It would therefore have to be marketed on its own merits as Indian turpentine oil, and in this case it might be expected to realise a price equal to or rather higher than that of good Russian turpentine oil.

Apart from the examination requisite for determining the commercial value of the oil, the study of its chemical constituents has been pursued by Mr. H. H. Robinson of the Imperial Institute, and a preliminary note has been communicated to the Chemical Society of London and published in that Society's Proceedings, 1911, Volume 27, page 247.

Oilseeds.—Samples of five oil-seeds, forwarded by the Director of Agriculture at Dacca, were examined and valued. Four of the varieties, *viz.*, "Raina," "Nahar," "Panang" and "Taramani" seeds, would probably find a ready market in the United Kingdom, but, in the case of the first three, technical trials will be necessary to determine their exact value; a larger supply of these seeds was requested in order that this further investigation might be conducted. The "Taramani" seed (*Eruca sativa*) is already known in the United Kingdom and is used as a source of oil.

A consignment of Margosa seed from the United Provinces was found to yield a fat of dark colour and very unpleasant odour. The dark colour, which was due to the fermentation of the seed during transit, could be avoided, and if the odour can be removed by a simple process the fat could be utilised for soap-making. The matter is being further investigated at the Imperial Institute.

A memorandum was furnished to the Officiating Reporter on Economic Products on the composition of Hydnocarpus fats, including that of *H. Wightiana* ("Moratti" seed) from India, showing that these fats are unsuitable for edible purposes.

A paper giving an account of the scientific results obtained in the course of the work on Indian Bassia seeds has been communicated by Mr. R. G. Pelly of the Imperial Institute Staff to the London Section of the Society of Chemical Industry and published in that Society's Journal, 1912, Volume 31, No. 3, February 15th.

Cotton.—Samples of cotton from Trichinopoly, Akola (Berar) and Eastern Bengal and Assam were examined during the year. The samples from Akola were of exceptionally high quality, and it was recommended that their cultivation should be encouraged.

Fibres.—Samples of Sisal hemp, Sida fibre and Sisal tow, forwarded by the Fibre Expert at Dacca, were found to be of good quality, and similar fibres could probably be sold in large quantities in the United Kingdom. A small consignment of the Sida fibre was subsequently forwarded by the Fibre Expert and was sold in London at £27 per ton. The fibre was however valued at £28 to £30 per ton (July 1912) if shipped in commercial quantities.

A sample of wild plantain fibre from Burma was clean, soft, and lustrous, and would be readily saleable in the United Kingdom; it was suggested that a small consignment should be forwarded to the Imperial Institute for trial sale.

Minerals.—Samples of china clay, bauxite, sandstone, red ochre and other minerals were examined and reported on.

Miscellaneous official enquiries.—In addition to the foregoing reports, information was furnished during the year to Government officials in India on a variety of subjects, including the following:—

The analysis of feeding-stuffs.

The utilisation of rat-skins.

The commercial value of fish oils, fish stearin, and vegetable oils.

Bamboo pulp as a paper-making material.

The marketing of sandalwood.

The preparation and storage of compressed fodder.

The marketing of barley.

The commercial value of dried bananas.

The determination of prussic acid yielded by beans.

The cultivation of peas and beans in Burma.

Coal prospecting in Gwalior.

Rosa grass distillation in Gwalior.

A number of other miscellaneous enquiries, received from commercial firms and private individuals in the United Kingdom, India and elsewhere, were also dealt with during the year, information being furnished to the enquirers on Indian oil-seeds, tanning materials, minerals, foodstuffs and other subjects.

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Departmental Publications.

I.—Meteorological Department.

Government of India Office.

(1) The Indian Daily Weather Report and Chart.
(2) The Weekly Rainfall Summary.
(3) The Monthly Weather Review.
(4) The Annual Summary.
(5) The Rainfall of India.
(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.
(2) Monthly Rainfall Tables and Summaries of the chief features of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).
(2) Annual Summary.
(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(2) Annual Summary
(1) Monthly Summary } of Punjab weather.

II.—Geological Survey.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I—XXXIX, including the larger papers on geological subjects.

Records, Vols. XLI, including the shorter papers and Annual Reports from 1868 to 1910, sold in parts, price one rupee each.

Manuals, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

III.—Survey of India.

(1) Annual General Report.

(2) Professional Papers.

IV.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.

(2) Records of the Botanical Survey, Vols. I—V.

(3) The Agricultural Ledger.—A series of papers on economic products issued as ready.

(4) Annual Report of the Industrial Section, Indian Museum.

(5) Annual Report of the Royal Botanic Garden, Calcutta.

(6) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientic officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in Agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British India by the Inspector-General of Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually.

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(2) The Indian Forester.—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal, published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) The Records of the Indian Museum, 8vo. Containing short papers on Indian zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalogue of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

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